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The Department of Defense

DEPARTMENTS/AGENCIES PARTICIPATING:

Department of the Army

Department of the Navy

Advanced Research Projects Agency

Special Operations Command

PROGRAM SOLICITATION 93.2
CLOSING DATE: 2 AUGUST 1993

PROGRAM SOLICITATION

Number 93.2

Small Business Innovation Research Program

IMPORTANT

The DoD is updating its SBIR Mailing list. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form will result in no future mailings of the DoD SBIR Program Solicitation to your address.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: AUGUST 2, 1993

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Advanced Research Projects Agency (ARPA), and U.S. Special Operations Command (SOCOM) hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0 hereof.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(703) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
Building 5, Cameron Station
Alexandria, Virginia 22304-6415
(800) 225-3842 toll free
(703) 274-6903 commercial

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commericalization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) will not be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete RED COPY of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete RED COPY of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. *Describe:*

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential private sector application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD

Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.

(3) Cost for travel funds must be justified and related to the needs of the project.

(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

n. Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and commercialization status for each Phase II. All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

A proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research,

(2) the existence of second phase funding commitments from private secor or non-SBIR funding sources,

(3) the existence of third phase follow-on commitments for the subject of the research, or

(4) the presence of other indicators of commercial potential of the idea.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than February 2, 1994. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 500 Phase I awards from this solicitation.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of

Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government*, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. See special instructions for each DoD Component in Section 8.

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. Specific instructions are provided by each DoD Component in Section 8.

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A Sample SF 298 is provided in Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:

  (a) Distribution authorized to U.S. Government Agencies only; report contains proprietary data produced under SBIR contract. Other requests shall be referred to the performing organization in Block 7 of this form.

  (b) Approved for public release; SBIR report, distribution unlimited.

(3) The report abstract (Block 13 of the SF 298, "Report Documentation Page") must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract may be published by the DoD, it must not contain any proprietary or classified data.

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted within the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, Cameron Station, Alexandria, VA 22304-6145.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices

A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)_________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit <u>classified material</u> with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a <u>reasonable time period</u> to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for <u>a period of four years</u> from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the four-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not. See FAR clause 52.227-20, "Rights in Data - SBIR Program".

5.9 Cost Sharing

Cost sharing is permitted for proposals under this

solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information

contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, August 2, 1993. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than July 26, 1993 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE:

the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DoD. DTIC prepares a Technical Information Package (TIP) on each SBIR topic. The package includes information such as a reference list of related technical reports and expanded topic description from the topic author. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DoD-sponsored Information Analysis Centers (IACs), where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requesters who responded to previous DoD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DoD funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DoD sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DoD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-6902 (Commercial)

DTIC Boston Regional Office
DTIC-BLNB
Building 1103, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
DTIC-BLNA
AFWL/SUL Bldg. 419
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles Regional Office
DTIC-BLNL
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

DTIC Matris Office
ATTN: DTIC-AM, Sally Ames
San Diego, CA 92152-6800
(619) 553-7008

Use Reference B at the back of this solicitation or telephone DTIC to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible. To assure the fastest possible mail service, give DTIC your Federal Express Account Number to which mailing charges will be made for overnight delivery.

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

University of Southern California
3715 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(213) 743-6132

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
237 Wisenbaker Engineering Research Center
College Station, TX 77843-3401
(409) 845-8762

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 450
Cleveland, OH 44070
(216) 734-0094

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburg, PA 15260
(412) 648-7000

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913 (local)
(800) 225-0308 (national)

Information Strategists
814 Elm Street
Manchester, NH 03101
(603) 624-8208

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to

participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR receipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B and C follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, and Appendix C is an outline for the Cost Proposal. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

U.S. Army 93.2
Submission of Proposals

Topics

The Army has identified 330 new topics for this solicitation, many of which address Operating Support Cost Reduction (OSCR), Critical Technologies especially relevant to the Army, the Army Science and Technology Master Plan, and the Star 21 Strategic Technologies for the Army of the twenty-first century. An attempt has also been made to identify the commercial potential of these initiatives.

Dollar Caps

The maximum dollar amount from the SBIR budget for Army Phase I awards is $70,000. Additional program dollars may be added by the program activity. To reduce the funding gap between Phase I and Phase II, firms may submit an option task not to exceed $30,000 with the Phase I proposal. Exercise of such an option would be intended to allow Phase II preparatory work to be initiated; however, the option does not obligate the Army to make a Phase II award. Firms who are awarded the option should reflect the funds as a deduction on the total cost of their Phase II proposal. Future Army Phase IIs will average about $600,000. Those companies who have been invited to submit a Phase II proposal and have almost finished their Phase I work must submit a plan on how they will commercialize the technology with the government or with the private sector in addition to the technology demonstration portion of the proposal if they desire to compete for a Phase II. Cost sharing options in Phase II are encouraged and will be used as an evaluation factor for proposed Phase IIs over $600,000.

Army Technology Clusters

These topics have been grouped into ten Army Technology Clusters. They are:

A-1 Advanced Materials and Manufacturing (Structural & Energetic Materials)

A-2 Micro Electronics and Photonics

A-3 Sensors and Information Processing (Communications)

A-4 High Performance Computing and Simulation (Modeling Displays, AI, Virtual Reality)

A-5 Advanced Propulsion Technologies (Mobility and Lethality)

A-6 Power Generation, Storage and Conditioning (Directed Energy, Microwave)

A-7 Biotechnology

A-8 Life, Medical and Behavioral Sciences

A-9 Environmental and Geo Sciences (Environmental Protection and Space)

A-10 Engineering Sciences (Robotics, Dynamics, Structures, Mechanics, and Construction)

Industry-Generated Future Topics

To enhance industry involvement in the Army SBIR process, I welcome suggestions from small firms for future Army topics. Kindly forward your topic ideas to me **after** this solicitation closes. Unsolicited proposals will not be accepted.

J. Patrick Forry
Army SBIR Program Manager

Commander
U.S. Army Materiel Command
ATTN: AMCRD (Mr. J. Forry)
5001 Eisenhower Avenue
Alexandria, VA 22333

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Army Topics

Phase I proposal (5 copies including 1 red-printed form) should be addressed to:

Commander
U.S. Army Materiel Command
ATTN: AMCRD (Mr. J. Forry)
5001 Eisenhower Avenue
Alexandria, VA 22333

ARMY SBIR PROGRAM
POINTS OF CONTACT SUMMARY

A93-037/A93-069	ARDEC	J. Greenfield	(201) 724-6048
A93-070/A93-072	ARI	A. Naphy	(703) 274-8840
A93-073/A93-074	ARO	M. Brown	(919) 549-4336
A93-075/A93-076	ARL	D. Hudson	(301) 394-4808
A93-077/A93-079	AC&ISD	R. Dimmick	(410) 278-6955
A93-080/A93-082	BED	O. Johnson	(505) 678-3608
A93-083/A93-102	E&PSD	R. Stern	(908) 544-4666
A93-103/A93-106	HR&ED	J. Sissum	(410) 278-5815
A93-107/A93-121	MD	B. Morrissey	(617) 923-5522
A93-122/A93-133	S3I	S. Corbett	(301) 394-4603
A93-134/A93-135	VAL	O. Johnson	(505) 678-3608
A93-136/A93-140	VPD	P. Meitner	(216) 433-3715
A93-141/A93-142	VSD	J. Cline	(804) 864-3966
A93-143/A93-146	WTD	R. Dimmick	(410) 278-6955
A93-147/A93-176	AVRDEC	R. Warhover	(314) 263-1074
A93-177/A93-181	BRDEC	K. Gordon	(703) 704-2279
A93-182/A93-211	CECOM	J. Crisci	(908) 544-2665
A93-212/A93-217	CERL	D. Moody	(217) 373-7290
A93-218/A93-227	ERDEC	R. Hinkle	(410) 671-2103
A93-228/A93-231	CRREL	C. Martinson	(603) 646-4244
A93-232/A93-233	DDESB	C. Canada	(703) 325-8624
A93-234/A93-259	MEDICAL	A. Wolf	(301) 619-7216
A93-260/A93-281	MICOM	O. Thomas, Jr.	(205) 842-9227
A93-282/A93-299	NATICK	B. Rosenkrans	(508) 651-5296
A93-300/A93-314	SDC	E. Roy	(205) 955-4393
A93-315/A93-322	STRICOM	A. Piper	(407) 380-4287
A93-323/A93-342	TACOM	A. Sandel	(313) 574-7545
A93-343/A93-350	TECOM	R. Cozby	(410) 278-1481
A93-351/A93-352	TMDE	C. Bosco	(205) 876-1132
A93-353/A93-358	TEC	J. Jamieson	(703) 355-2631
A93-359	AEC	R. Eichholtz	(410) 671-1561
A93-360/A93-366	WES	P. Stewart	(601) 634-4113

SUBJECT/WORD INDEX TO THE ARMY SBIR SOLICITATION

SUBJECT/WORD — TOPIC NO.

INDEX OF ARMY FY93 TOPICS

A93-150	Advanced Lightweight Armor Concepts
A93-159	"More Electric" Advanced Magnetic Materials
A93-167	Affordable Development/Rapid Prototyping of Complex Aircraft Components
A93-179	Reduced Weight Power Generation and Air Conditioning Units to Improve Army Mobility
A93-189	Direct Optical Fiber Glass Formation Techniques using Chemically and/or Physically Removable Filamentary Substrates
A93-225	Synthesis of Conducting Polymers for Screening in the Microwave Region of the Electromagnetic Spectrum
A93-266	Alternative Manufacturing Techniques for MMW Mechanical Assemblies
A93-268	Integration of Reliability, Maintainability, and Product Life of Missile Systems with Affordable Technology **(CANCELLED)**
A93-282	Multispectral Camouflage Printed Uniforms
A93-285	Materials and Manufacture Methods for Chemical Protective Gloves
A93-287	Improved Ballistic Protective Material System(s) for Integrated Multiple Threat Protection
A93-289	Development and Evaluation of Unique Flame-Resistant, Insulative Battings
A93-290	Biomimetic Ceramics
A93-293	Smart Membranes From New Polymer Gels
A93-294	Dual-Ovenable, Recyclable High Barrier Polymeric Food Container
A93-295	Oxynitride Glass Fibers
A93-296	Ultrasonic Quilting of Insulation Batting Materials
A93-297	Loaded Semipermeable Membranes for Chemical and Biological (CB) Protective Clothing
A93-299	Adaptive Camouflage
A93-303	High Energy Laser Material Science Basic Experimental Controls Design **(CANCELLED)**
A93-324	Large Area Passive Broadband Laser Filters
A93-327	Subsystem Research - In-Situ Multifunctional Monitoring Systems
A93-328	Adaptive/Tunable Composite Structures
A93-330	Joining of Composite Materials
A93-331	Tribological Coatings for Wear Applications
A93-332	Subsystem Research - Appurtenance Attachments for Composite Systems
A93-336	Self-Healing Primers for Long-Term Corrosion Protection of Metallic Substrates
A93-338	Flexible Chemical Agent Resistant Coating (CARC)

A93-341 Lightweight Carbon-Carbon Pistons for High Temperature Engines

A93-345 Deformable Mirror Device Dynamic Infrared Scene Projector

A-2 MICRO ELECTRONICS AND PHOTONICS

A93-074 Affordable Design of Electronic Structures Incorporating Resonant Tunnelling Elements

A93-083 Temperature Insensitive Laser Diode Arrays

A93-091 Non-Destructive Optical Evaluation of Thin Layer Semiconductor Heterostructures

A93-093 Novel Josephson Junctions for Intrinsic Voltage Standards

A93-096 DC to RF Laser Diode Characterization System

A93-185 Microelectronic Display (MIDIS) Technology

A93-323 Double Focus Unity Magnification Vision System

A93-354 Downsized Color Reproduction System

A-3 SENSORS AND INFORMATION PROCESSING (I.E. COMMUNICATIONS)

A93-039 Low Cost Laser Radar (LADAR) Technology for Smart Submunition Target Sensing

A93-044 Passive Aero-Acoustic Sensor Self Interference Cancellation

A93-047 Multipath Interference at Millimeter Wave Frequencies

A93-049 Characterization of Atmospheric Turbulent Effects for Acoustic Transducer Windscreen Design

A93-077 Token Ring Protocols for Packet Radio

A93-087 Vibration-Insensitive Dielectric Resonator Oscillators and New Ceramic Materials for Microwave Oscillator Applications

A93-088 Synthesis of Materials for Uncooled IR Detectors

A93-089 Novel High Frequency Optical Modulators

A93-094 Millimeter Wave Sensor Technology for Identification of Freind or Foe (IFF)

A93-097 Miniature Atomic Clock Technology

A93-100 Ferroelectric Smart Microsensor

A93-101 Novel Active High Temperature Superconducting Devices

A93-122 Diffractive Optical Elements for Laser Diodes

A93-123 Fast Computation of Iterative Maximum Likelihood Estimator for Continuous Wave (CW) Tone Extraction

A93-124 Artificial-Intelligence-Enhanced Signal and Information Processing

A93-125 Low Cost, Highly Stable Oscillator Systems

A93-126	Charge Coupled Device (CCD) Evaluation using the Modulation Transfer Function (MTF)
A93-127	Two-dimensional Individually-addressable Laser Diode Arrays
A93-128	Wideband frequency selective limiter
A93-129	Foveal Vision Algorithms
A93-130	Neural Based Automatic Target Recognition (ATR)
A93-131	Two-dimensional Optical Signal Processing Architecture and Components for Planar Optics
A93-132	Gun-rugged Accelerometers and Vibratory Gyroscopes
A93-133	Miniature Charge Coupled Device (CCD) Driver-Controller
A93-134	High Frame Rate, Snap Shot Infrared Imaging Focal Plane Array
A93-135	UWB Antennas
A93-147	Machine Health Monitoring with Multi-Domain Smart Sensors
A93-148	In Situ Fatigue Life Monitor
A93-180	Low Cost Electric/Electronic Governor for Small (5-20hp) Diesel Engines
A93-182	Soldier's Radio: Innovative Communications and Networking Technologies for the Individual Warrior
A93-183	Soldier Audio Orientation and Integrated Command, Control and Communications System
A93-184	Soldier's Computer Concepts in Maintenance and Logistic Applications
A93-186	Very High Frequency (VHF) Helix Antenna
A93-187	Advanced Video Compression Techniques
A93-188	Spread Spectrum Technology for Communications on the Move
A93-190	Interoperable Power Adapter and Charger (IPAC) Technology
A93-191	Parallel Processing Effort
A93-192	Soldier Identification (SID)
A93-193	Millimeter Wave (MMW) Radar Measurement of Ice Formation on Aircraft Wings
A93-194	Radar and Communications Intercept and Analysis System
A93-195	Radar Target Simulators
A93-196	Advanced Deception Techniques
A93-197	Synthetic Aperture Radar (SAR) Countermeasure (CM) **(CANCELLED)**
A93-199	Large Well Capacity Input Circuit
A93-200	Superlinear Readout Integrated Circuit (ROIC)

A93-201 Zero Droop Readout Integrated Circuit (ROIC) Thermal Reference Substraction (TRS)

A93-202 Technology for Transition from Ada 83 to Ada 9X

A93-203 Management Metrics Decision System

A93-204 Ada 9X Graphical Design Support

A93-205 Intelligent Multi-Mode Tactical Communications Interface

A93-206 Solar Power Array/Satellite Communications Antenna

A93-207 Versa Module Euro Standard (VMEbus) (ANSI/IEEE-1014-1987) Compliant Radio Frequency (RF) Down Convertor

A93-209 Frequency Scan Optimization

A93-210 Advanced Hardware for Intelligence Electronic Warfare (IEW) Common Architectures

A93-211 Data Communications Support for C4I for the Warrior

A93-260 Wavelet Characterization of Clutter for Enhanced Detection and Identification of Low Flying Targets

A93-269 Transmitter-Receiver Isolation for Continuous Wave (CW) Radar Antenna

A93-272 Real Time Lossless Data Compression Techniques

A93-273 MILLIMETER WAVE CONFORMAL ANTENNA **(CANCELLED)**

A93-274 Wide Bandwidth End-Fire Slotline Ring Antenna **(CANCELLED)**

A93-278 Low Noise Frequency Agile Exciter **(CANCELLED)**

A93-300 Visible Sensors

A93-301 Anti-Satellite Kinetic Energy Weapons **(CANCELLED)**

A93-302 Use of Tactical Lasers in Mine Detection and Counter-Mine Operations

A93-305 Hydroacoustic Impact Location System for the East Reef Area of the Kwajalein Atoll (KA)

A93-307 Prediction of Rocket Exhaust Plume Microwave Attenuation for Kwajalein Atoll (KA) Launches **(CANCELLED)**

A93-310 Automated Reduction of Kwajalein Missile Range (KMR) Optical Metric Data **(CANCELLED)**

A93-311 Economic Value of Weather Support for Range Operations **(CANCELLED)**

A93-312 Optical Sight Line Characterization

A93-313 The Use of Infrared Technology for Tracking and Scoring **(CANCELLED)**

A93-314 Use of Satellite-Based Radiometry in CLEARSKY for Support of Range Operations **(CANCELLED)**

A93-315 Advanced Audio Cue Generation and Projection for Distributed Interactive Simulation (DIS) Platforms

A93-316 Force/Tactile Feedback for Virtual Reality Environments

A93-326 Preview Sensor Development

A93-334 Battlefield Acoustics Model

A93-344 Rapid Measurement of Artillery Tube Elevation and Azimuth

A93-346 Vehicle Position Location System

A93-350 Applications of Radar Imaging to High-Altitude Measurements

A-4 HIGH PERFORMANCE COMPUTING AND SIMULATION (I.E. MODELING DISPLAYS, AI, VIRTUAL REALITY)

A93-037 Fire Control Battlemanagement and Decision Support System Technology

A93-042 Position Location, Navigation and Fire Control Map Interface Unit

A93-048 Neural Network Based Speech Identification/Transcription Module

A93-063 Molecular Holographic Sensor

A93-078 Simulation Interfacing Techniques

A93-079 Simulation Technology: Virtual Factory and Process Simulation

A93-086 Optics for Head Mounted Displays

A93-092 Interaction with 3-D "Virtual" Environments

A93-103 Fire Support Suppression Effects in Battlefield Simulation

A93-105 Development of Performance and Effectiveness Measures to Support Evaluations of Unmanned Ground Vehicles (UGV) Technologies and Operations

A93-146 Quick-look Geometry and Vulnerability Description for Armed and Attack Helicopters

A93-155 Graphical User Interface for Finite-Element Based Comprehensive Rotorcraft Analysis Software

A93-160 Expert Systems Conflict Resolution

A93-164 Application of Parallel Processing Technology to Complex Helicopter Analysis

A93-168 Methods for Pre-Flight Risk Assessment in Army Aviation

A93-170 Intelligent Information Presentation for a Helmet Mounted Display in a Synthetic Environment

A93-171 Application of Virtual Reality to Helicopter Target Acquisition, Pilotage and Simulation

A93-172 Light Weight Small Volume Stereoscopic Visual Sensors for Telepresence on Robotic Rotorcraft Research Vehicles

A93-198 Modeling of Automatic Target Recognizer Performance

A93-208 Contextual Benchmark Features for use within AI Scripts

A93-221 High-Speed Transient Waveform Acquisition System

A93-233 High Explosive Structural Damage Assessment Model Computer Code Enhancement

A93-262 Human Operator Model Baseline Architecture Simulation (HOMBAS)

A93-263 Computer Aided Software Engineering (CASE) tool for Software Maintainability Feedback for Software

A93-265 Logistics-Sustainment Technical Assessment Simulation

A93-267 Man-In-The-Loop Trainer for Non-Line-of-Sight Combined-Arms (NLOS-CA) and The Army Combined Arms Weapon System (TACAWS) **(CANCELLED)**

A93-271 Improved Missile Guidance Simulator Target Position Control for Precision-Guided Weapons **(CANCELLED)**

A93-275 Software Assemble Expert System

A93-281 Application of Neural Network & Fuzzy Logic Theory to An Autotracker Design

A93-306 Fusion of Kwajalein Missile Range (KMR) Optical and Radar Data for Enhanced Deep Space Surveillance **(CANCELLED)**

A93-308 Global Positioning System (GPS) Error Modeling for Incorporation into Post-Mission Trajectory Estimation

A93-309 Film-to Video Conversion **(CANCELLED)**

A93-317 Visual Data Base Feature Extrapolation

A93-318 Measurement of Cost Effectiveness as a Result of the Use of Training Devices/Simulators

A93-319 Application of Contemporary Psychological Research to Training Devices and Simulators

A93-320 Analytical Augmentation of Player Units in a Distributed Interactive Simulation (DIS) Environment

A93-321 Next Generation Dismounted Infantry Interactive Simulation Environment

A93-322 An Instrumentation and Threat Target Simulation Requirements Generation System **(CANCELLED)**

A93-325 Test and Analysis of Ada Language Programs

A93-329 Data Base "Mining" through Machine Intelligent Learning Algorithms

A93-348 Image Processing Using Temporal Cellular Neural Networks

A93-349 Automated Foward Looking Infrared (FLIR) Resolution Measurement Using Fuzzy Logic & Neural Networks

A93-353 GPS-driven Battlefield Visualization

A93-356 Massively Parallel Graphics Workstation For Battlefield Visualization

A93-357 Cartographic Animation System

A-5 ADVANCED PROPULSION TECHNOLOGIES (I.E. MOBILITY AND LETHALITY)

A93-076 Critical Interior Ballistic Effects for Regenerative Liquid Propellant Guns

A93-136 Advanced High Temperature Strain Isolator Material System

A93-137 Depleted Oxygen Gas Turbine Combustor Design

A93-138 Brush Seal Shaft Wear Resistant Coatings

A93-139 Electromotive Propulsion Concepts for Rotorcraft

A93-140	Fast Acting Valves for Turbomachinery Bleed Applications
A93-149	Electrical Energy Recovery for Gas Turbine Engine Exhaust
A93-156	Surge Control for Turboshaft Engines
A93-157	High Velocity Combustors for Gas Turbine Engines
A93-161	Particle Trajectory Analysis for Turbine Engine Inlets
A93-162	Adaptive Electric Anti-Icing for Turbine Engine Composite Inlets
A93-163	Braze Joining Ceramic Matrix Composite Components for Turbine Engines
A93-165	Ceramic Matrix Composite Component Improved Load Bearing for Turbine Engines
A93-173	Turbine Engine Component Repair Concepts
A93-174	Auxiliary Bearings for Turbine Engine Magnetic Bearing Systems
A93-261	Personal Computer Based, Graphical User Interface Configured, Generic Airbreathing Propulsion System Cycle Deck
A93-270	Low Cost Generic Digital Thrust Controller for Tactical Missile Smart Propulsion Systems
A93-277	Portable Static Test Facility for Small Expendable Turbojet Engines
A93-279	Windows Based Graphical User Interface for FORTRAN Based Propulsion System Analysis Codes
A93-284	Airdrop Impact Decelerator Using Magnetic Technology
A93-333	Air Tank Recharging System
A93-337	Advanced Military Diesel Engine
A93-339	Innovative Heat Pipe Cooling System
A93-340	Heat Exchanger Precleaner
A93-342	Electric Drive Power Conditioning Units

A-6 POWER GENERATION, STORAGE AND CONDITIONING (I.E. DIRECTED ENERGY, MICROWAVE)

A93-075	Precision Triggered High Power Oil Dielectric Spark Gap Switches For Flash Gamma-ray And X-ray Simulators
A93-084	Ferroelectric Capacitors for High Resolution - FPAs
A93-085	Very High Energy Primary and Rechargeable Lithium Batteries and Battery Chargers
A93-095	Solid Electrolyte for Fuel Cells
A93-098	Components for Thin Film Bipolar Pulse Power Batteries
A93-099	Dielectric Materials for High Energy Density Capacitors
A93-102	Array of High Power, Photon Triggered Ultra-wideband RF Radiators

A93-143	Magnetic Induction Launch-Coils for Plates or Plate-Like Structures
A93-177	Future Soldier System Power Source
A93-304	High Energy Laser Gaussian Beam Generation Optical Development **(CANCELLED)**
A93-347	Ultra-Wide Band Electromagnetic Source Development **(CANCELLED)**
A93-335	Infrared Lamp and Reflector

A-7 BIOTECHNOLOGY

A93-073	Engineering Ribosomal Biosynthesis
A93-220	Development of Non-Mammalian Antibody Expression Vectors
A93-243	Fused Cholinergic Synaptosomes
A93-246	Hydrazine Air Monitor

A-8 LIFE, MEDICAL AND BEHAVIORAL SCIENCES

A93-070	Executive-Level Decision Skill Enhancement
A93-071	Component-Group Training Strategies
A93-072	Measuring the Costs and Benefits of Army Service
A93-104	Human Performance Issues in Automatic Target Recognition and Situation Awareness Displays
A93-106	Development of an Unmanned Ground Vehicle (UGV) Simulator
A93-166	Adaptive Algorithms for Optimal Configuration of Cockpit Information
A93-176	Non-Lethal Weapons For Helicopter Use
A93-218	Generic Biodetection
A93-219	Biosampling
A93-223	Flow Cytometry
A93-224	Less-Than-Lethal Immobilizing Chemicals
A93-226	Chemiluminescence and Bioluminescence
A93-227	Bifunctional and Catalytic Antibodies
A93-234	Passive Immunoprophylaxis And Immunotherapy of Malaria
A93-235	Systems to Automate The Deglycerolization of Thawed Frozen Human Blood.
A93-236	Directed Biosynthesis Or Isolation of Soluble Porcine Lipopolysaccharide Receptors
A93-237	Neutralizing Monoclonal Antibodies Against Biological toxins

A93-238 Development of A Reactive topical Skin Protectant (RTSP)

A93-239 Develop Methods For In Vivo Delivery of Dengue Proteins to The Cytoplasm of Cells For Antigen Processing And Presentation

A93-240 Tissue Adhesives For Battlefield Hemorrhage Control

A93-241 Medical Vision Enhancement Prosthesis For Military Laser Retinal Injury

A93-242 Development of Field Oriented, Nucleic Acid Amplification Methods For Rapid Identification of Biological Threat Agents

A93-244 Development of Diagnostic Probes For The Detection And Surveillance of Drug Resistant Parasitic Infections

A93-245 Systems to Detect Bacterial Contamination of Banked Blood In A Rapid, Non-invasive, Low Technology Manner

A93-247 Identification And Diagnosis of toxin Exposure And Infectious Diseases

A93-248 Remote Water Quality Evaluation

A93-249 Delivery of Vaccines By Biodegradable Polymeric Microcapsules With Bioadherence Properties

A93-250 Development of In Vitro And Animal Model Tests to Assess User Acceptability of topical Skin Products

A93-251 Mobile Field Waste Incinerator

A93-252 Medicinal Chemistry Synthesis of Potential Drugs Effective Against toxic Agents of Biological Origin

A93-253 Development of An Aviator Restraint System Locking Device

A93-254 Medical Countermeasures Against "toxic Agents of Biological Origin"

A93-255 Development of Anthropometric Analogous Headforms

A93-256 Cellular Immune Response to Diseases of Military Importance

A93-257 Insert Hearing Protector With Communications Enhancement For High Intensity Impulse Noise Environments

A93-258 Human Immuno-deficiency Virus (HIV) Research

A93-259 Development of A Portable, Ultralow Freezer For Preservation of Biological Products In An Austere Environment

A93-286 An Analysis of Soldier Biomechanics Using Ambulatory Monitoring Techniques

A93-343 Develop an Enzyme or Fluorescent Linked Anti-body Based Biological Agent Detection/Assay System for Particulate Antigens

A-9 ENVIRONMENTAL AND GEO SCIENCES (I.E. ENVIRONMENTAL PROTECTION AND SPACE)

A93-046 Improved Luminous Tritium Sources

A93-050 Development of a Chemical/Mechanical High Rate Process for the Detection of Residual Stress in 5.56mm Brass Cartridge Cases

A93-054 Electro-chemical Machining of Refractory Materials for Gun Barrels

A93-055 Cleaning of Depleted Uranium from Metal Parts

A93-056 Preferred Orientation in Tungsten Heavv Alloys (WHA)

A93-057 Coated Tungsten Alloy Composites

A93-058 Tungsten Alloys with Enhanced Ballistic Performance

A93-062 Development of Environmentally Friendly, Cost-Effective and Scaled-Up Synthetic Processes for New High Energy Density Materials

A93-064 Development of Nonpolluting Soldering Technology for Large Production Volume, High Shock Loaded Electronics Circuit Boards

A93-080 Aerosol Cloud Imagery Identification and Segmentation

A93-081 Scanning Bi-Static Sodar for Measuring Wind Structure Parameter

A93-082 Normal Mode Analysis of Atmospheric Sound Ducts

A93-212 Arid Land Revegetation with Blue-Green Algae

A93-214 Heavy Metal Ion Removal by Magnetic Particle Wastewater Treatment

A93-215 Heavy Metal Adsorption From Combustion Gas

A93-222 Evaluation of Supercritical Fluid Extraction Technology for Decontamination

A93-229 Rapid Measurement of Ice Density

A93-230 Near-Infrared Spectral Reflectances of Earth Materials

A93-231 Millimeter-Wave Backscatter from Cold Regions Terrain

A93-355 High-speed Vehicle Positioning And Reporting System

A93-358 Mobile Fax Map Distribution System

A93-359 Feasibility Study to Determine the Ability to Use an In-situ Vitrification Tent to Contain Open Burning Gases

A93-360 Alternative Solvents for Asphalt Cement Extractions

A93-361 Site Characterization and Analysis Penetrometer System

A93-362 Controlled Camouflage Systems for Advanced Land Combat Applications **(CANCELLED)**

A93-363 Radar Antenna Optimization

A-10 ENGINEERING SCIENCES (I.E. ROBOTICS, DYNAMICS, STRUCTURES, MECHANICS AND CONSTRUCTION)

A93-038 Intelligent Sensor Based Robotic Control System Technology

A93-040 Micro-Mechanically Steerable Optical/IR Scanner

A93-041 Azimuth Orienting Device for Towed Artillery and Mortars

A93-043	Advanced Adaptive Weapon Control Technology
A93-045	Simulation of Optical Surface Errors Resulting from Manufacturing Processes
A93-051	Automated Vision Inspection of Threaded Weapon Components
A93-052	Soldier Weapons Improvement by Development of an EMAT (Electromagnetic Acoustic Transmission) System for Non-Destructive Inspection of Cannon Tubes
A93-060	Automation Friendly Fuze Packaging
A93-067	Non Destructive Inspection By Infrared Imaging Spectroscopy
A93-090	Microscale Sensors and Actuators
A93-151	Helicopter Rotor Blade Trailing Edge Control Surface
A93-152	Damperless Helicopter Rotor Blade
A93-153	Helicopter Rotor Blade One/Rev Vibration Reduction
A93-154	Composite Rotor Blade Sectional Analysis
A93-158	Electronically Survivable Composite Airframe Primary Structures
A93-169	Remotely Piloted Rotorcraft for Cargo Delivery
A93-175	Helicopter Weapons Deployability, Operability, and Supportability **(CANCELLED)**
A93-178	Affordable Technology for Magnetic Signature Duplication
A93-181	Diesel and JP-8 Homogeneous Mixture Fueled Rotary Engine
A93-213	Programmable Logic Controller Energy Management Programs
A93-216	Sensors for Intelligent Low-Maintenance Corrosion Control in Industrial Water Systems
A93-217	Development of Operating and Support Cost Reduction Processes in Building Construction
A93-228	Development of Crashworthy W-Beam Guardrail Manufactured from Light-Weight Fiber Reinforced Plastics (FRP)
A93-232	Development of an Asset Oriented Approach for Facility Lightning Protection
A93-264	Innovative Annular Motorcase Shell Designs
A93-276	Non Eroding Nozzle Material Development
A93-280	Unstructured Grids for Computational Fluid Dynamics Applications
A93-283	Atomization of Diesel Fuel for Combustion
A93-288	Development of an Immersion Water Heater for Field Applications
A93-291	Closed-cycle Regenerative Field Refrigeration (CRFR)
A93-292	Diesel-Fired and JP8-Fired Lantern for Field Use
A93-298	Modular Microclimate Conditioning System

A93-351 Concurrent Engineering (CE) Tool for Diagnostics

A93-352 Prognostic Methodologies for Electronics or Mechanical Systems

A93-364 Equipment and Procedures for Placement of Dowel Bars in Hardened Concrete

A93-365 Ground Penetrating Radar for Pavement Applications

A93-366 Laser Range Sensor for Pavement Applications

DEPARTMENT OF THE ARMY

FY 1993 TOPIC DESCRIPTIONS

A-1 ADVANCED MATERIALS AND MANUFACTURING (I.E STRUCTURAL & ENERGETIC MATERIALS)

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-053 TITLE: Ammunition Loading Hazards Detection for Artillery/Armor

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a capability for reliably: (1) recognizing that hazardous conditions for loading ammunition into cannon have developed, (2) alerting operators that loading should be interrupted, and (3) operating in the training/operational environment of combat vehicles after full development.

DESCRIPTION: Direct and indirect fire gun and ammunition systems have a history of occasional malfunction which sometimes result in critical injury to the weapon crew. The rapid advancements in the sensor and microprocessor fields has provided a new potential capacity for automatic detection of the onset of such unsafe loading conditions in cannon. Hazards to the continued loading and operation of the gun/ammunition system have been specified; they include hot/burning ammunition residues. Experimental data are being collected on these hazards in the laboratory and in live fire experiments. A workshop on the automatic detection problem yielded a problematic approach to synthesizing automatic detection of hazardous conditions. This effort requires further technology developments in sensory systems, high performance computing capabilities and detection algorithms for application with direct and indirect fire systems. Special interests lie in the potential application of fusion of spectrographic data, focal plane arrays, laser semiconductor arrays and the chemical tagging of ammunition elements. This topic requires: (1) extension in the taxonomy of hazards in cannon/ammunition systems (including the analytical/experimental development of spectral emissions signatures for each type of hazard) (2) characterization of emission for the byproducts of combustion of ammunition (including evaluation of the influence of transmittance on the detection process) and (3) determination of the types, levels and effects of background radiation from external sources. An approach applying the development of neural nets to discriminate between hazardous and non-hazardous states in the gun could be applied. The required algorithms and coding must render a reliable detection in the very limited time available for interruption of the gun loading process.

Phase I: Develop the methodology and data base to support system design activity for artillery/armor system(s). Perform any necessary laboratory bench simulations required to confirm feasibility of the design approach. Synthesize a conceptual design (Class I drawings) for a demonstration prototype system. Identify system requirements in terms of hardware (sensors, microprocessors, cabling, installation fixturing, etc.) decision algorithm(s) and prospective software needs. Prepare an outline test plan for the demonstration of the system.

Phase II: Complete the detailed design and synthesis of a demonstration system. Provide a test/demonstration plan, maintenance test support package and on-site test support for demonstration of the brassboard in live gun firings by the government at a proving ground or comparable facility. Provide a written technical report on the work.

Potential Commercial Market: No foreign or domestic source for any such detection and warning system exists. There is no known and currently funded effort addressing the development and application of these technologies to the problem identified. Areas where its application exists include: currently fielded U.S. Army direct and indirect fire systems, the Advanced Field Artillery System (AFAS), the Advanced Tank Armament System (ATAS), gun/ammunition systems extent in the other services (U.S. Navy and U.S. Marines), foreign systems, and industrial base equipment/processes for private and consumer manufacturing. In addition, many key technology componenets would be useful in constructing a system to identify concealed explosives and their stability.

OSCR: This topic provides technologies to accomplish OSCR by application: (1) to combat systems to reduce the frequency and severity of accidents causing critical injury to personnel and/or damage to materiel, and (2) to acceptance testing of ammunition to reduce the expenditures for ammunition. These technologies are required to support automated ammunition handling in combat systems and a concomitant reduction in Operations and Support Costs.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-059 TITLE: Blow-Molded Ammunition Container Development

CATEGORY: Engineering Development

OBJECTIVE: Complete development of a qualified light-weight plastic container for implementation into production for large-caliber ammunition and propelling charges.

DESCRIPTION: The blow-molded container evaluated under a PIP program during the 1984-1985 timeframe performed very well in its qualification test program. The technical advantages of the container included light weight, ruggedness, corrosion elimination and reduced ammunition logistics costs. The container was not selected, primarily due to problems with the closure design maintaining a 3 PSI seal. This program will improve the closure design, including the selection of molding process and gasket material, to achieve long-term storage capabilities. In addition, molding parameters will be established to ensure reproducibiity.

Phase I: The contractor shall work with existing container molds and tooling designs as baseline criteria. Recommendations shall be made for modifications to the closure design, material selection and processing parameters. At the end of Phase I the contractor shall deliver a report that includes proposed design, material and/or process improvements.

Phase II: The contractor shall implement design, material, and/or process changes recommended in Phase I to the existing container molds and tooling. These changes shall be such that the molded container will be able to meet the rigors of Level A military packaging as outlined in MIL-STD-1904. Upon completion of Phase II, the contractor shall deliver 50 containers of an agreed-upon design to the U.S. Government for qualification test, and a final report that includes changes made to the design/material/processing, test data and evaluation results.

Potential Commercial Market: The blow-molded container for large caliber ammunition will be developed with emphasis on the seal design for long term purposes. Once the container is qualified in the test program, the design will be phased into the ammunition packaging system. Since both the raw material and the developed processes are commercially available, no major problems would be anticipated for this transition. In addition, to phasing the design into the ammunition packaging system, opportunities exist for applying the developed technology to lightweight packaging that must maintain a pressure barrier against the outside environment.

OSCR: The blow-molded container provides significant benefits in areas of light weight, ease of handling, no corrosion problems and lower unit cost. As a result, the life cycle cost reduction is estimated to be 20% less than the current system.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-061 TITLE: Formulation of Pyrotechnic Compositions with Solventless Binders

CATEGORY: Exploratory Development

OBJECTIVE: Develop Pyrotechnic Compositions containing solventless binders and identify processing techniques for such compositions.

DESCRIPTION: Many pyrotechnic compositions contain organic binders which are incorporated into the composition by dissolution into volatile organic solvents (vos) and subsequent blending with the remaining composition constituents. During mixing, the vos evaporate. Most states severely restrict the open emission of vos. Consequently, plants manufacturing pyrotechnics must use solvent recovery systems to comply with environmental laws. It would be desirable to eliminate totally or greatly reduce vos from pyrotechnic manufacture. This would yield two benefits. First, although vos emission is controlled, it would be more environmentally advantageous to eliminate vos altogether. Second, solvent recovery systems represent a considerable portion of overall pyrotechnic processing costs. Elimination of these systems would yield a cost savings.

Phase I: Select binders suitable for use in pyrotechnic compositions. Selection criteria include physical, chemical characteristics, availability, toxicity, cost. Determine processing schemes to incorporate binders into selected pyrotechnic mixes without use of vos.

Phase II: Produce bench and pilot scale batches of pyrotechnic compositions using solventless binders. Load into items and perform static functioning tests. Optimize composition formulations and processes to achieve acceptable item performance. Gather data required for scale up to load plant production.

Potential Commercial Market: Techniques developed for this project would be directly transferable to reduction of vos in other similar environmental processes.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-065 TITLE: Advanced Packaging Cushioning Material to Improve Performance in the Insensitive Munitions (IM) Fast Cook-off and Sympathetic Detonation Tests

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate new and innovative materials, coatings, and designs for packaging cushioning to protect munitions during the Insensitive Munitions (IM) Fast Cook-off and Sympathetic Detonation tests. Concepts developed must continue to provide the desired cushioning properties to protect the munition during packaging rough handling environments.

DESCRIPTION: The fast cook-off and sympathetic detonation tests are two IM tests and are described in MIL-STD 2105A. Ideally the advanced cushioning developed under this topic should address both the fast cook-off and the sympathetic detonation test criteria. However, if that is not possible, only one criteria may be chosen to be addressed. Many munition containers are constructed with a steel outer container. Polyethylene or polyurethane foam, bound fiber, or some other cushioning surrounds the munition to provide protection from the impacts and shocks of rough handling and environmental conditions. The IM fast cook-off test subject packaged munitions to a large fire. The required reaction of the munition in these tests is burning only. The tests do not have a time limit, but are conducted until the munition energetically reacts. Two possible approaches which use the packaging cushioning to protect munitions during the IM fast cook-off test are discussed. One approach is to use the packaging's cushioning to thermally insulate the munition from the fire. This will delay the munition's reaction time. Although a delayed time will not directly help a munition to "pass" the IM test, it will contribute a significant real world explosives safety benefit by providing valuable time to allow personnel to either fight the fire or evacuate the area. A second approach is for the packaging cushioning to undergo a phase change from solid to gas. This phase change may absorb thermal energy thereby insulating the munition. This approach may provide a secondary benefit of providing an internal pressure build-up within the container due to "out-gassing". This internal pressure may be engineered to result in controlled rupture and venting of the container, in contrast to the current reaction, which is often a rapid build-up of pressure culminating in a release of dangerous fragments. The IM sympathetic detonation tests and the hazard classification stack test evaluates the likelihood that a detonation reaction may be propagated from one unit to another within a group or stack of munitions. The required reaction of the acceptor munition in these tests is no detonation. Because this test is usually conducted with munitions in the packaged configuration, the packaging has the potential to mitigate and attenuate the explosive shock transferred from the donor to the acceptor munition. During the investigation, the maximum cushioning material used shall be four inches. The materials developed shall meet toxic fumes requirements as established by the Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists. The results of this investigation may benefit the IM performance and hazard classification of many Army munitions. The outbreak of fire in an ammunition storage area is widely recognized as the greatest hazard to explosive safety. This effort will reduce the consequences of this hazard, thereby greatly improving the safety of U.S. troops and civilians.

Phase I: Investigate new and innovative materials, coatings, and designs for packaging cushioning to protect munitions during the IM fast cook-off and sympathetic detonation tests while still providing the desired cushioning properties to protect the munition during packaging rough handling environments. Modeling and analytical evaluation shall be used to predict the success of the concepts. To address the fast cook-off test criteria, cushioning shall be developed which delays the time of reaction for a munition exposed to the IM fast cook-off tests. To establish a baseline, the investigator shall determine the insulating performance of currently used polyethylene and polyurethane foam and bound fiber. In addition to cushioning materials which provide thermal insulation, materials may be considered which may dissipate thermal energy by undergoing a change of state, such as from solid to gas. The "out-gassing" developed during this state change shall be quantified to determine internal pressure build-up leading to controlled rupture and venting of the container. Small scale testing using a heat source shall be used to simulate the actual fast cook-off test and will demonstrate the success of the various concepts. To address the sympathetic detonation test criteria, cushioning shall be developed which provides explosive shock attenuation, thereby increasing the likelihood of preventing sympathetic detonation. To establish a baseline, the investigator shall determine the explosive shock attenuating performance of currently used polyethylene and polyurethane foam and bound fiber.

Phase II: Implement the new cushioning concepts into actual munition containers. The prototype designs shall be tested in IM fast cook-off, sympathetic detonation, packaging simulated rough handling testing, and toxic fumes testing. Modified container designs shall not adversely affect container performance in simulated rough handling tests or toxic fumes test. The prototype designs shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

Potential Commercial Market: This technology would have application to the commercial packaging industry and fire protection industry. The development of new and innovative packaging materials, coatings, and designs would provide improved fire and heat protection for many commercial goods, with particular application to expensive and sensitive assets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-066 TITLE: Critical Fluid Extraction of Single-Base Gun Propellant Formulations

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate critical fluid extraction (CFE) technology for recovery of strategic ingredients from single-base gun propellant formulations (M1, M6, M10, etc.). The reclaimed NC can be utilized to support current and future production.

DESCRIPTION: The Conventional Ammunition Demilitarization Inventory (B5A Account) contains large quantities of single-base propellants (including M1,, M6 and M10) contained in bulk form and in munition items. Disposal by open burning/open detonation is currently being utilized. This practice must be phased out due to environmental restrictions. Controlled incineration of bulk propellant and explosive is a potential solution. However, reclamation and reuse is the preferred approach since this technology offers both environmental and economic advantages. Technology development will permit the recovery of nitrocellulose (NC) from single-base gun propellant. The feasibility of recovering strategic ingredients from Class 1.1 and 1.3 large rocket motor propellant formulations using CFE technology has been demonstrated using near critical liquid ammonia as the extraction solvent. This technology is currently being transitioned for pilot scale development by the Joint Service Large Solid Rocket Motor Research and Development Program. A similar process using a different extraction solvent requires evaluation for application to conventional gun propellants.

Phase I: Set-up laboratory equipment to demonstrate critical fluid extraction can be employed to recover useful ingredients for recycle and reuse utilizing various extraction solvents. Testing will be performed to proveout the concept of extracting nitrocellulose (NC) from single base propellant using critical fluid technology. Different extraction solvents will be evaluated to perform the recovery. The optimum solvent will be identified. All solvents must be environmentally acceptable and capable of being completely recycled.

Phase II: Design, install the process equipment and perform bench scale testing on various single base propellant formulations using the optimum solvent identified in Phase I. Design criteria will be developed to transition the technology to the pilot phase. The physical and chemical properties of the reclaimed material will be evaluated in order to optimize the extraction process. In addition, a cost analysis will be performed to determine the economic advantages for proceeding to the pilot plant stage.

Potential Commercial Market: Critical fluid extraction technology is a proven technology that can be commercialized for recovery of NC from single base propellant. The technology can be implemented at GOGO/GOCO facilities to support ammunition production, consequently eliminating the need for disposal by open burning/open detonation. The CFE process involves the fluidization of gases to near critical liquid and supercritical fluid conditions. The fluid serves as the extraction solvent based on the solubility of the solute. The solubility of the solute in the solvent changes rapidly as process control parameters such as temperature and pressure are varied. Understanding the process chemistry based on the ingredient solubilities permits the extraction of the ingredients for recycle and reuse. Development of CFE process under the SBIR program for single-base gun propellant formulations will allow tangible and intangible benefits. The conventional ammunition demil inventory will be reduced in a more environmentally responsible manner by eliminating the need of open burning/open detonation. The CFE approach will provide a new source of raw material. The reclaimed NC can be utilized in the production of small caliber munitions to reduce manufacturing costs.

OSCR: The SBIR proposal to develop critical fluid extraction technology for recovery of NC from single-base gun propellant formulation will provide the most efficient environmentally acceptable alternative to open burning and open detonation for conventional munitions. Recycle and reuse of NC will also support future production readiness. the technology can also be readily applied to extract and recover strategic ingredients (NC, NG, and NQ) from multi-base gun propellants. The objective of this proposal is to develop a cost efficient critical fluid extraction process to recover and reclaim high purity NC from off-spec and obsolete single-base gund propellant formulations. In addition, ammunition maintenance operating efficiency will be maximized by the recovery and recycle of NC. The estimated quantity of obsolete single-base gun propellant in the demilitarization stockpile is in excess of 10 million pounds. A cost savings at a minimum of $10 million can be realized through successful development of this program.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-068 TITLE: Extended Barrel Life

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate extended barrel life through the use of wear reducing ammunition additives.

DESCRIPTION: Performance requirements for existing and future systems demand improved lethality at longer ranges. The development of high energy charges to meet these requirements has had an adverse effect on gun barrel life. While barrels manufactured using exotic materials may meet the need, the cost of such an approach may prove prohibitive. The use of wear reduction materials integral to the ammunition could improve barrel life of existing systems and complement future barrel designs.

Phase I: Select a gun system for evaluation. Using the selected gun system as a baseline develop ammunition concepts which embody barrel wear reduction additives. For each concept developed predict barrel life improvement, cost of implementation, estimate the caliber range and duty cycle in which the concept would be applicable.

Phase II: Using the base line system establish the barrel wear profile through collection of available data, gun firings and fixture testing. Build ammunition using selected wear reducing additives and test barrel life improvement. Provide complete documentation of test results.

Potential Commercial Market: Successful development of this technology may also be transitioned to the commercial gun industry for sport weapons (guns and rifles) for hunting and target shooting. In addition, other government agencies (FBI/CIA) may have a direct interest in ammunition developed with the additives developed in this proposal.

OSCR: Successful development and implementation of this technology would result in reduced life cycle costs and increased equipment availability. Life Cycle costs could be reduced in two ways. First, barrel life or existing systems could be extended without weapon modifications. Secondly, when used as a systems approach to solving barrel were concerns would result in cost effective barrel designs. Barrel life extended through either approach would further reduce life cycle cost and increase system availability through reduced supply and maintenance costs and an extended duty cycle between maintenance requirements.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-069 TITLE: Diamond and Diamond-Like Coatings

CATEGORY: Exploratory Development

OBJECTIVE: Demonstration of controlled deposition and bonding of diamond and/or diamond-like coatings to weapon wear surfaces.

DESCRIPTION: Wear surfaces in small arms and automatic weapons have been lubricated with oils and greases which retain dirt and other contaminants, and whose coefficient of friction varies with temperature. Diamond and diamond-like coatings offer the potential of permanent, low friction coatings, impervious to dirt and temperature variations. This effort should demonstrate controlled deposition of the coating, proper bonding to the substrate, low coefficient of friction and controlled crystal composition.

Phase I: Determine the feasibility to deposit diamond and/or diamond -like coatings on weapon wear surfaces. Design a prototype system capable of achieving the goals outlined in the above description. Initiate development of plans for Phase III commercialization.

Phase II. Build and test prototype system capable of achieving the above goals. Test and evaluate system performance. Complete plans for phase III commercialization.

Potential Commercial Market: The proposed technology would find immediate application in many commercial areas that require low coefficient of friction between moving parts.

OSCR: Most weapon systems wear surfaces are lubricated with oils and greases which dry out and become embedded with dirt, sand and other contaminants resulting in premature wear and failure. Successful development of this process would result in an increased weapon duty cycle and large reductions in logistical costs associated with resupply, maintenance and manufacturing costs

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-107 TITLE: Method for Reduced Cost Fabrication of Boron Carbide Ballistic Tiles

CATEGORY: Exploratory Development

OBJECTIVE: Develop a processing method for production of ballistic grade boron carbide ceramic which provides a minimum of fifty percent reduction in materials costs.

DESCRIPTION: Ceramic armor materials offer the benefit of high mass efficiencies to armor designers, but are limited in application by a number of factors, including cost. Boron carbide, in particular, suffers from this disadvantage with normal costs running in excess of $100 per pound. In order to obtain suitable performance levels, boron carbide must currently be produced by hot pressing or by hot isostatic pressing (HIP) techniques. This results in a material with appropriate properties such as a high elastic modulus and a high percentage of theoretical density (>99%), however, these production methods do not offer significant potential for cost savings via process optimization. An alternative processing method is sought that could yield tiles with equivalent properties at an overall cost reduction of at least fifty percent to permit expanded use of boron carbide in armor packages.

Phase I: Demonstrate process feasibility by producing fully dense materials with suitable mechanical and physical properties and deliver samples to the Army for evaluation. Determine the economic feasibility of using the proposed process for industrial production based on the cost of raw materials and the unit process steps required.

Phase II: Scale-up the process method selected in Phase I to produce tiles of sufficient size to allow ballistic testing (minimum: 6x6x1-inches) and deliver samples to the Army for evaluation.

Potential Commercial Market: Reduced cost boron carbide ceramic has a variety of potential applications aside from armor. These include high-temperature and wear applications in both military and commercial markets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-108 TITLE: High Purity Powders for Oxide and Non-Oxide Ceramics for Armor Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop high purity, sinterable powders for subsequent use in armor ceramic applications.

DESCRIPTION: Current armor ceramics are required to be processed to near full density. The primary barrier to achieving this goal is the inconsistent quality (powder size, distribution and purity) of the starting powders presently available. Recent developments in the use of exothermic reactions, sol-gel processing, plasma spraying and chemical vapor deposition(CVD), and preceramic polymers (to name a few) to produce powders and net shape products offer the potential to produce high purity powders (single or binary phase) with a reduction in cost.

Phase I: Develop a high purity, powder processing technique for a transparent or opaque armor ceramic application. Produce and thoroughly characterize stoichiometric (or near stoichiometric) polycrystalline single or binary phase powders. Materials of interest include, but are not limited to: silicon carbide, titanium diboride, boron carbide, aluminum oxide, aluminum oxynitride and magnesium aluminate(spinel). Produce sufficient powder to meet the deliverables which will include two tiles measuring 4-inches in diameter by 0.3-inches in thickness and 250 grams of powder. The density of the processed powder must be greater than 99 percent of theoretical density (equal to or less than one percent porosity). For transparent materials, in-line transmission must be greater than 80 percent.

Phase II: Scale-up the powder production technique to produce large ceramic tiles for ballistic evaluation against various threats. Minimum deliverable is twelve tiles of 6x6-inches by 1/2 to 1-inch thickness size. Evaluate other potential compositions using the same technique. The processing cost goal is $10/pound or less.

Potential Commercial Market: Commercial markets currently exist for high purity ceramics processed to near full density. The product applications include wear, engine and electronic components.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-109 TITLE: Process Control for Resin Transfer Molding

CATEGORY: Exploratory Development

OBJECTIVE: Develop resin transfer molding (RTM) technology for the innovative processing of lower cost, medium volume production of medium to very large woven and stitched structural composite components in a thermoset matrix.

DESCRIPTION: RTM has great potential for low cost and rapid production of very large structural composite components. Consequently, the technology is in a rapid development stage. Innovative processing techniques are needed to control and monitor the flow of resin within the molding cavity. The specific focus should be to develop a reliable, repeatable comprehensive system, whereby the resin can be independently "steered" in the x, y, and z directions within the mold cavity, while the resin movement and location is monitored in real time. For example, this could be accomplished through a combined application of pressure, vacuum, and the use of multiple-port injection and venting. Manipulation of the preform permeability could be another exploitable parameter.

Phase I: Develop a resin flow control system and a real-time resin location monitoring scheme. Clearly demonstrate feasibility for low part rejection rate via benchtop experimentation. Deliver RTM-processed composites to the Army for evaluation. Thoroughly critique the potential for large-scale production.

Phase II: Construct the prototype equipment and demonstrate that it is capable of meeting the resin flow and monitoring objectives described above, i.e., that, once in the mold cavity with the preform, control over resin movement and tracking its location has been mastered. Deliver test parts of varying contours, angles, and thicknesses to the Army for evaluation.

Potential Commercial Market: Availability of innovative process control for resin transfer molding would find applications for low cost, rapid production of large structural composite components in military and commercial markets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-110 TITLE: Consolidation/Compaction of Nanocrystalline Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques and processing for the consolidation/compaction of nanocrystalline materials

DESCRIPTION: Recent successes in developing nanocrystalline materials opens up the opportunity for greatly improving the mechanical and physical properties of components made from those materials. An important consideration is the consolidation/compaction of the nano-sized particles into useful structure. This process must occur without the loss of the nano-scale of the powder, and hence grain size. Traditional metalworking (and ceramic) processing is not applicable due to the high temperature and extended processing times involved. Novel techniques may be required. An additional consideration is the potentially pyrophoric nature of the nano-powder. This limits the ease by which the powder is handled and perhaps limits the consolidation methods available.

Phase I: Identify and demonstrate effective processing of nano-scale materials and/or improved handling of these materials.

Phase II: Scale-up and demonstrate the generic nature of the unit processes identified in Phase I and deliver samples to the Army for evaluation.

Potential Commercial Market: A clear need exists to develop consolidation processes for nano-scale powder. Development in nano-powder production must proceed with consolidation or no advantage will be forthcoming. The potential is as great as the range of nano-materials. Ductile ceramics are possible as well as strong, ductile metals and intermetallics.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-111 TITLE: Novel Materials for Laser/Ballistic Protection

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel transparent, laser- and ballistic-resistant materials/technologies for passive, dynamic, broad-band protection for both biological and instrumental sensors. Potential Phase III applications for these new materials include laser-safety glasses, goggles, windshields, vision blocks, and direct and indirect view optics.

DESCRIPTION: The Army has a need for improved laser-resistant materials against broad-band, agile lasers. Conventional polycarbonate structure incorporated with laser absorptive dyes and/or reflective filters usually has degraded ballistic properties and only provides adequate laser protection against specific wavelengths. Thus, innovative, laser/ballistic materials and technologies are needed against agile, broad-band laser threats. Proposals will be considered that address either of the following approaches/qualifications: (1) New laser resistant materials/systems effective against mid- to high-energy out-of-band lasers with ballistic protection comparable to or greater than polycarbonate. (2) Passive or active optical-switchable laser blocking materials/systems for broad-band low energy laser protection in the 400-1200 nm spectral region with at least 50 percent photopic transmission and an optical density greater than 4 when laser irradiation is present, and ballistic protection equivalent to or better than polycarbonate.

Phase I: Develop one or more hybrid transparent materials concepts to protect Army personnel and optical sensors against broad-band laser threats and demonstrate feasibility.

Phase II: Optimize and scale-up the most promising laser-blocking materials system demonstrated in Phase I. Develop a full-scale prototype system for a specific Army application and demonstrate its effectiveness against agile laser threats. Deliver the prototype to the Army for additional tests and evaluations.

Potential Commercial Market: Improved transparent laser- and ballistic-resistant materials, effective against agile laser threats, would find applications in laser-safety glasses, goggles, windshields, vision blocks, and direct and indirect view optics.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-112 TITLE: Engineered Perceramic Polymers for Confined Space Conversion

CATEGORY: Exploratory Development

OBJECTIVE: Develop a preceramic polymer which is designed for conversion in confined spaces to silicon carbide or silicon nitride and which is useful as a binder and as a matrix material for a ceramic composite.

DESCRIPTION: Preceramic polymers currently serve as an important route to continuous fibers for composite materials. However, there is growing evidence that preceramic polymers can also serve important roles as binders and as precursors to the matrices of ceramic fiber composites. To optimize their use in these situations, the polymers often need to be designed for a long shelf life and low weight loss conversions to stoichiometric, crystalline conversion products without extensive and costly furnace times.

Phase I: Design a preceramic polymer which can be handled in laboratory air and which shows less than eight percent porosity during conversion to a near stoichiometric silicon carbide or silicon nitride conversion product when used as either a binder or a composite matrix material. The conversion product must be ninety-five percent crystalline at the end of the heat schedule. Demonstrate the feasibility and usefulness of using this polymer in either a binder application or a composite matrix application through microstructural and mechanical property analyses. Deliver two plates of the final ceramic material produced, measuring about 2.5x2.5x1/8-inches or more, and 25 grams of the polymer.

Phase II: Scale-up the Phase I polymer material production process and produce large-scale ceramic materials, including a component demonstration piece using the polymer in both a binder and a composite matrix application. Demonstrate the processability and reproducibility of the ceramic materials. Evaluate the elevated temperature mechanical performance of the materials.

Potential Commercial Market: Commercial markets already exist for technical ceramics, especially for those with good high temperature mechanical properties. The material requirements specified in this SBIR topic area should lead to the fabrication of high quality materials which would be readily marketable.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-113 TITLE: Smart Materials for Army Applications.

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate effective smart materials concepts for applications to Army systems.

DESCRIPTION: Recently there has been intense activity in the development of "smart" or "intelligent" materials and functionally graded materials. This activity has been pursued enthusiastically in Japan and Europe. Some typical features of these so called smart materials are as follows: -Embedded or bonded or intrinsic sensors which recognize and measure the intensity of environmental stimuli such as stress, strain, thermal, electric, magnetic, electromagnetic, chemical, biological or nuclear. -Embedded or intrinsic actuators to respond in a prescribed or desired way to the stimulus. -A control mechanism or selected response is available to respond to the stimulus in a predetermined way. The response occurs in a short or appropriate time and the material returns to its original state on removal of the stimulus. The purpose of this topic solicitation is to capitalize on such materials developments to enhance performance in applications to Army ground and air vehicles, armor, large structures and machine components. Proposal are sought on the development of smart materials to: -Reduce shock and vibration -Defeat armor piercing weapons -Enhance battle damage resistance -Act as artificial muscles for exoskeletons -In situ sensors, actuators and monitoring capability for a wide range of environmental conditions or more effective maintenance and life prediction of Army systems, components or equipment.

Phase I: Develop and demonstrate the feasibility of the smart material concept proposed for application to Army systems.

Phase II: Develop and deliver a prototype of the smart material concept selected in Phase I and demonstrate its effectiveness on a realistic application to an Army system.

Potential Commercial Market: Smart materials developments that enhance performance would find applications in military and civilian markets, etc.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-114 TITLE: Tungsten Materials for Kinetic Energy Penetrators

CATEGORY: Exploratory Development

OBJECTIVE: Development of a tungsten-based material for use in kinetic energy(KE) penetrators to replace depleted uranium(DU).

DESCRIPTION: It is desired to replace DU in ordnance applications for health, safety and environmental reasons. The direct substitution of tungsten alloy for uranium alloy is not possible due to performance differences between the two. DU alloys, as KE penetrators, perform 5 to 10% better, depending upon test method and conditions. The performance gap has been attributed to an adiabatic (localized) shear that occurs in the DU alloy that prevents the formation of a mushroom head on the nose of the penetrator. The lack of a mushroom head allows greater penetration. Tungsten alloys that have been considered are two-phase composites in which the minor phase acts as a binder for the tungsten phase. The binder is composed of nickel with iron, cobalt and/or copper. Several efforts have addressed the replacement of this binder with ones that should be more susceptible to a shear localization in an effort to mimic the DU behavior. These have not been successful. Further investigation into alloying, processing and fabrication of tungsten alloys/composites is necessary in order to meet the performance goal for tungsten-based KE penetrators.

Phase I: Demonstrate the proposed concept for application as a KE penetrator. Deliver scale-model penetrators for sub-scale testing.

Phase II: Scale-up processing, as necessary. Prepare Sub-scale projectiles for further testing and also develop material scale-up for full-scale tests.

Potential Commercial Market: Commercial markets include penetrators for mining and oil exploration. Other potential applications for tungsten alloys developed include sporting goods, electrical and electronic and counterweight applications.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-115 TITLE: Micromechanical Measurement System for Thin Films on Polymeric Substrates

CATEGORY: Exploratory Development

OBJECTIVE: Develop a micromechanical measurement system to assess and enhance the structural reliability designed into transparent polymeric products such as canopies and windshields, vision blocks, goggles and face shields.

DESCRIPTION: Transparent organic plastics have a variety of military and civilian applications including helicopter canopies and aircraft windshields, vision blocks for vehicles, goggles for soldiers and chemical laboratory personnel, and face protection for police and riot control personnel. Unfortunately, plastic materials, specifically polycarbonates, are susceptible to scratching as well as degradation from exposure to organic solvents. Potential hardcoatings, such as diamondlike carbon and other inorganic oxides, have shown the capability of providing polycarbonate with significant enhancement in resistance to abrasion and chemical attack. The thicknesses of these high performance coatings are generally on the order of 0.05-0.1 microns, much thinner than commercially available hardcoatings. Although fabrication techniques recently developed for producing such ultra-thin film materials or coatings on temperature sensitive polymeric substrates have shown much progress, our understanding of the micromechanical properties of the interfaces at these extremely small dimensions lags far behind. A device is needed to measure the micromechanical properties to assess the adhesive strength and fracture toughness, and to evaluate the micromechanical failures of critical high performance protective hardcoatings used in Army systems. Since polymeric materials are of relatively low hardness and these ultra-thin coatings can delaminate or fail at extremely small applied loads, the proposed test apparatus should posses high resolution in the applied load and displacement measurements. The proposed system should be practical and versatile, and efficient in terms of sample preparation.

Phase I: Determine the feasibility of designing and developing a micromechanical system to effectively measure the adhesive strength and fracture toughness of ultra-thin films coated on polymeric substrates. Demonstrate the feasibility of the systems capability to achieve high resolution in the applied load and displacement measurements and to facilitate correlation of micromechanical properties with micromechanical failures.

Phase II: Develop and deliver an optimized prototype of the proposed micromechamical measurement system addressed in Phase I. Demonstrate the capability of this prototype to measure the adhesive strength and fracture toughness and to characterize the mode of failures of transparent polymer-based armors used in Army systems.

Potential Commercial Market: Development of a new micromechanical measurement system to assess and enhance the structural reliability designed into individual protection transparencies products for military and commercial markets. Prospective product applications include: canopies and windshields, vision blocks, goggles and face shields.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-116 TITLE: Ambient-Temperature-Storable Thermoset Resin

CATEGORY: Exploratory Development

OBJECTIVE: Develop an ambient-temperature-storable thermoset resin system that does not require refrigeration or special handling and maintains its properties over a six-month minimum storage period.

DESCRIPTION: Structural polymer composites today use either a thermosetting or thermoplastic matrix, the large majority being thermosets, such as epoxies and polyesters. One of the most attractive advantages of thermoplastics (and conversely one of the least attractive aspects of thermosets) is an unlimited shelf life at ambient temperature. From a practical logistics standpoint, this feature is superb. It eliminates the task of ratio mixing the resin components and, more importantly, eliminates the need for refrigeration and special handling. On the other hand, thermosetting systems are much easier to process, making them the more popular matrix resin system despite the fact that they have a limited shelf life (even when refrigerated). A mixed, ready-to-use thermoset resin that does not require refrigeration or special handling, with properties similar to current resin systems, would be an important practical advantage to the military and industrial community. Some potential approaches to the solution include a scheme for keeping the reactive chemical components physically separated in the mixed state, or a chemical scheme whereby a third party chemical additive blocks the curing reaction.

Phase I: Identify the most promising approach to meet the objectives. Demonstrate clear feasibility of the selected approach to allow a mixed thermosetting resin system to meet a specified 72 degrees Fahrenheit, six-month storage requirement. Supply samples of the resin to the Army for evaluation.

Phase II: Fully develop the most successful approach in Phase I and formulate the resin system. Clearly demonstrate the capability of the resin system to meet the storage requirements, cited above, followed by chemical and physical property evaluations. The cured resin properties must be similar to those of current elevated-temperature-cured structural systems. Supply resin and glass cloth preimpregnated with the resin to the Army for evaluation.

Potential Commercial Market: A ambient-temperature-storable thermoset resin would find wide applicability throughout the composites community because of the cost savings involved in reduced waste and the availability of reliable thermoset resin systems.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-117 TITLE: Bonding of Ceramic Materials for Structural Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a bonding technique suitable for a variety of technologically important ceramic materials which will allow them to be bonded together and used in elevated temperature (greater than 1000 degrees centigrade) applications.

DESCRIPTION: As monolithic and composite ceramics are used in high temperature applications, such as engines and exhaust systems, there is a growing need to be able to bond similar and dissimilar ceramics materials to each other. While a variety of joining techniques already exist, e.g., microwave joining or joining by slurry at either the green body stage or after firing, they typically have at least one drawback, such as: (1) they are limited to the bonding of two very specific materials, and/or (2) the resulting joint greatly limits the elevated temperature mechanical properties.

Phase I: Demonstrate a bonding technique which can be employed to join both oxide and non-oxide ceramics, as well as both similar and dissimilar compositions (ceramic materials to be joined can be either monoliths or composites). Any degradation of the mechanical properties of the bonded system, when compared to the properties of the unbonded material(s), must not be greater than five percent at temperatures ranging from 20 to 1300 degrees centigrade. The surfaces to be bonded must be at least 1/2x1/2-inches in dimensions.

Phase II: Optimize and scale-up the technology to effectively bond larger surface areas and complex surfaces and produce component demonstration pieces. Demonstrate the processability and reproducibility of the joining techniques for both an oxide and a non-oxide ceramic system, when joining both similar and different compositions. Determine the mechanical properties of the bonded materials at temperatures ranging from 20 to 1300 degrees centigrade.

Potential Commercial Market: The ability to bond ceramics would have applications in two areas. First, complicated ceramic shapes, which cannot be mass produced reliably and which are prohibitively expensive to machine, can be produced by bonding together simpler shapes. Secondly, as ceramics play a larger role in areas such as engines and exhaust systems, different ceramic materials will be used for different components due to the requirements of the applications. There will be a growing need to be able to reliably join these components together.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-118 TITLE: Nondestructive Method for Detecting Chemical Warfare Agent Contamination of Composite Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop a nondestructive method for detecting and identifying chemical warfare agent contamination of organic matrix composite structures.

DESCRIPTION: Fiber reinforced organic matrix composite materials are finding increased use in structures for Army applications. One of the threats facing Army materiel in the field is contamination by chemical warfare (CW) agents. Although these agents are delivered in the form of small droplets, they represent considerable danger to personnel. Undetected agents on the surface are an immediate hazard. Subsequent decontamination treatments may or may not completely neutralize them. In addition, agents may diffuse into the organic matrix. Surface decontamination may not neutralize interior agents, which can then diffuse back to the surface after days or weeks to recontaminate the surface, unbeknown to personnel. A nondestructive evaluation (NDE) technique is needed to alert personnel to dangerous CW contamination on the surface or just beneath the surface of composite materials. Critical regions of the structures must be scanned, perhaps by an optical or spectroscopic means or by generation of surface color changes by an applied detection medium. Next to be performed could be local heating of the surface by a hot air gun or radiant energy source, followed by scanning as above, to reveal any significant subsurface contamination. The proposed NDE system must be field-portable, easy to use, environmentally benign, and not harmful to the composite materials.

Phase I: Demonstrate the feasibility of detecting and identifying surface and subsurface CW contamination of organic matrix composite materials of potential use to the Army. The technique should be nondestructive and should provide a means for scanning selected areas of the composite structure.

Phase II: Develop and deliver a field-portable NDE prototype system as proposed in Phase I. Demonstrate the capability of this prototype to detect and identify surface and subsurface CW contamination of composite structures.

Potential Commercial Market: A new field-portable NDE system to detect and identify CW agent contamination of organic matrix composite materials.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-119 TITLE: Novel Approaches to Bond Quality Nondestructive Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: To identify and demonstrate the feasibility of previously unexplored methods for the nondestructive evaluation (NDE) of adhesive bond quality, both as initially fabricated and as a function of service in extreme (hot/wet) environments. Bond quality implies at least a semi-quantitative indication of bond strength.

DESCRIPTION: At present, a major barrier to the optimum utilization of adhesive bonding as a joining method in primary structure in Army materiel is the absence of a NDE technique capable of indicating bond quality and thus, structural integrity. The extent to which this is a barrier may be judged by the position taken by the aerospace community: "IF YOU CAN'T INSPECT IT, YOU CAN'T FLY IT." Current techniques, such as ultrasonic inspection and infrared(IR) thermograpy, are capable of detecting voids and delaminations, but these defects usually have little to do with bond quality. An extreme case in this regard is the so-called "kissing bond" in which there is intimate contact between adhesive and adherend, but no bond exists. This condition cannot be detected by current methods. Since bond strength is determined by and deterioration most often occurs in the interphase region of a bond, techniques which can provide information as to the physical, mechanical and chemical properties of this region are required as a basis for new approaches to bond quality NDE. Instruments/equipment to be derived from any such new approach must be factory as well as field deployable.

Phase I: Identify a particular approach to be taken and show feasibility by demonstrating a strong correlation between predicted bond quality for a range of appropriately flawed test specimens and the results of destructive testing of these same specimens. Both initially fabricated and hot/wet aged conditions should be addressed.

Phase II: Develop and deliver an optimized version of equipment based on the approach demonstrated in Phase I. Conduct both factory and field demonstrations of appropriate prototypes.

Potential Commercial Market: There is a major market in the commercial aviation sector for an instrument capable of bond quality NDE.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-120 TITLE: Ion Beam Modification of Polymer Surfaces for Chemical Protection Applications

CATEGORY: Exploratory Development

OBJECTIVE: Modify the surface/subsurface of plastics and elastomers using ion beam technology to enhance chemical resistance and reduce chemical vapor permeation.

DESCRIPTION: Chemical resistance and organic vapor permeation in polymeric materials is affected by a number of factors, such as mean free volume, surface functionality, cross-link density, surface wettability, and solubility of the organic penetrant in the polymer, to name a few. Ion beam modification of polymers has been shown to affect all of these properties to various extents. There is often a trade-off made when chemical resistance is required, in that other polymers with less desirable physical properties are selected. Ion beam modification may provide enhanced chemical resistance without altering bulk physical properties. The process will not suffer from bond delamination, as chemical resistant coatings can, since ions are implanted below the surface and become a permanent part of the material. For an ion beam modification technique to be successful, many beam conditions would need to be explored and optimized. New instrumentation may need to be constructed to process numerous end-items, with complicated shapes.

Phase I: Demonstrate the small-scale utility of ion beam processing to the enhancement of chemical resistance and/or the reduction of chemical vapor permeation rates/breakthrough times for plastics or elastomers.

Phase II: Develop or utilize large-scale ion beam equipment capable of rapid, inexpensive implantation of polymeric end-items with potentially complex shapes.

Potential Commercial Market: Provide enhanced surface resistance to chemical attack and vapor permeation for elastomers and plastics using ion beam surface preparation. Applications exist for medical, petroleum and other industrial fields that utilize polymers for chemical resistance/protection.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-121 TITLE: Functionally Gradient Materials for High-Temperature and Severe Environment Structural Applications

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop an effective fabrication technique to produce a selected metal/functionally gradient material(FGM)/ceramic system suitable for structural applications.

DESCRIPTION: Severe service conditions, including high temperature differentials and high thermal stresses, warrant the development of high-performance materials to join metals and ceramics. Example applications include a protective shield in a corrosive engine environment and a heat shield in space planes, where the surface temperatures can reach 1800 degrees centigrade and an oxiding environment exists. A ceramic layer on a structural metal imparts desirable heat-, abrasion- and corrosion-resistant characteristics to the structure and allows it to be used in more severe environments. Pairing a ceramic with a metal leads to various processing problems including: wetting and bonding of the metal to the ceramic, interface reactions, and a mismatch between the thermal expansion coefficients of the materials which leads to residual stresses. The prospects of using FGM's as a solution to these problems has generated much excitement, but an effective, practical, reliable and affordable fabrication technique needs to be developed to implement the technological development.

Phase I: Target a specific application and environment and select an effective metal/FGM/ceramic system. Demonstrate the feasibility of fabricating such a system and assess the economics of industrial production. The demonstration should include a testing program suitably outlined to measure/examine the system's structural integrity/reliability and properties after repeated exposure to the targeted environment, i.e., thermal cycling or exposure to corrosive propellants.

Phase II: Develop and fabricate the proposed system addressed in Phase I. Demonstrate the capability of the system by producing and performing validation tests on optimized samples of the selected metal/FGM/ceramic system. Deliver the samples to the Army for additional evaluation.

Potential Commercial Market: A new fabrication technique to increase the reliability of joining ceramics to metals to withstand severe environments in high performance structural applications in military and commercial markets.

TECHNOLOGY CLUSTER: A-1

TOPIC: A93-141 TITLE: A Device for Inserting Discontinuous Through-The-Thickness Reinforcements in Thick Dry Fiber Preforms

CATEGORY: Exploratory Development

OBJECTIVE: To Develop a Single Barrel gun that will shoot Through-The Thickness (TTT) reinforcement rods through thick dry fiber preforms. The concept developed shall be extendable to multibarrel configurations.

DESCRIPTION: General - Damage tolerance and fabrication cost are driving issues in the design of composite primary structure. Some success has been achieved in the reduction of fabrication cost by utilizing textile technology to produce dry fiber preforms. Improvements in damage tolerance is achievable through toughened resigns and through-the-thickness (TTT) reinforcement. Methods of producing TTT reinforcement are stitching and tufting and integral weaving of braiding. The integral weaving or braiding of preforms with TTT reinforcement is applicable to a limited range of structure. Stitching and tufting have been only applied to flat or structures having slight curvature, such as wing skins. Stitching has typically been limited to preforms of less than an inch of thickness. Stitching is a slow method of inserting TTT reinforcement. For example on a typical wing skin of a commercial transport wing using a nominal stitch density of 60 stitches per square inch, 4 to 5 million stitch penetrations are required. utilizing a state-of-the-are multi-needle machine operating at 1hz required hundreds of hours to stitch a single wing skin. Furthermore, a thick stitched structure must be stitched to final shape because the stitched preform will not readily conform to other shapes without severely distorting the inplane fiber architecture of the preform. An alternate approach to stitching as a method of TTT reinforcement is to shoot a discontinuous rod (possible a cured composite rod) through the thickness of the preform. The technique envisioned is similar to a nail gun used in building construction. In this case instead of a fixed length nail, a continuous supply of rod would pay out, cut and loaded into the gun. Depending upon the thickness of the preform, its permeability and the type of fibers in the preform, the propellant (probably air) would be adjusted and the rod shot into the preform. A fully-automated high-speed, multi-barrel gun of this type would have many advantages over current stitching method of TTT reinforcement. Preforms could be assembled and debulked on the infiltration and curing took prior to the insertion of the TTT reinforcement. This would reduce the manipulation of the preform between stitching tools and infiltration and curing tools. It would also eliminate the need for stitching tools. Preforms having complex shapes and curvatures could be accommodated whereas this is not the case with stitching. Furthermore, preform thickness would not be an issue with a gun system. A gun system could be operated at rates approaching a machine gun firing rate which would reduce the time required to reinforce a large preform. The discontinuous nature of the rod TTT reinforcement eliminates the bending of inplane fibers which reduces compression strength of stitched composite laminates.

Phase I: Design, build, and demonstrate a single barrel gun for TTT reinforcement.

Phase II: Build and demonstrate a fully-automated high-speed, multi-barrel hun for TTT reinforcement.

TECHNOLOGY CLUSTER: A-1

TOPIC: A93-142 TITLE: A Variable Geometry Reed For Weaving Biase Directional Fabric That Has Variable Width.

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabric a reed for a loom whose reed dent wires can be arranged in such a manner as to simultaneously tailor the fiber orientation and shape of the fill yarn and the width of the fabric. If it is anticipated that this modified reed will require substantial computer control.

DESCRIPTION: Reduced fabrication cost and structural weight can be achieved in a composite structures through the development of advanced structural concepts. These advanced concepts are producible utilizing textile technology provided it is possible to change the angles to the warp yarns. When the fill yarn is inserted into the shed formed by the warp yarns and beatup into the fabric, the fill yarn conforms to the surface of the reed's dent wires. If the woven fabric is a unweave construction where the warp yarns represent only a few percent of the total yarn in the fabric, then the fill yarns are the only structural yarns in the fabric and the width of the fabric is controlled by the spacing of the warp yarns. Therefore, the reed plays a major roll in defining the architecture of the fabric. If it is possible to simultaneously change the shape of the reed during the weaving of a fabric, a significant cost and weight benefits could be achieved.

Phase I: Design and fabric a prototype reed for a loom whose reed dent wires can be arranged in such a manner as to simultaneously tailor the fiber orientation and shape of the fill yarn and the width of the fabric.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-144 TITLE: Algorithmic Aspects of Computational Terminal Ballistics

CATEGORY: Basic Research

OBJECTIVE: Improvement in the quality, reliability and performance of computational terminal ballistic simulations, focusing on the accuracy of material flow and failure algorithms. These simulations are characterized by conditions of large deformations, very high deformation rates, shock pressures and temperatures to a substantial fraction of melting.

DESCRIPTION: The performance of modern armor/anti-armor systems hinges upon the complex and often ill-understood flow and failure behavior of exotic materials (e.g., heavy metal alloys, advanced ceramics, energetic materials) loaded under conditions of ballistic impact. Areas of concern for large-scale terminal ballistic simulation include but are not limited to: physically-based penetrator/target interface erosion algorithms, physically-based algorithms for computation of behind armor debris, contact algorithms ported to massively parallel computer architectures, physically-based damage models for ductile and brittle materials, algorithms for the initiation of energetic materials, algorithms to handle phase changes and mathematical change of type in the governing equations.

Phase I: A successful effort will provide a description/analysis of algorithm(s) addressing one or more of these or related problems and a trial implementation in a 2D terminal ballistic code.

Phase II: A successful Phase II will demonstrate utility of the improved algorithm(s) implementation in a 3D terminal ballistics code approved by Army researchers. Demonstration of utility will involve comparison with relevant physical experiments.

Potential Commercial Market: This work is relevant to the simulation and modeling of high-rate forming and machining operations and for simulation of impact response of materials.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-145 TITLE: Material Modeling in Computational Terminal Ballistics

CATEGORY: Basic Research

OBJECTIVE: Improvement in the quality and reliability of computational terminal ballistic simulations, focusing on better experimental characterization and analysis of material flow and failure response. These simulations are characterized by conditions of large deformations, very high deformation rates, shock pressures and temperatures to a substantial melting.

DESCRIPTION: The performance of modern armor/anti-armor systems hinges upon the complex and often ill-understood flow and failure behavior of exotic materials (e.g., heavy metal alloys, advanced ceramics, energetic materials) loaded under conditions of ballistic impact. This loading environment is characterized by very large strains, strain rates and stresses experienced at temperatures from ambient to a substantial fraction of melting and over a wide range of pressures. Areas of concern for large-scale terminal ballistic simulation include but are not limited to: 1). Novel experimental techniques to characterize material response under CONTROLLED conditions approximating the ballistic impact environment. Such tests would feature high-rate biaxial loading with independent stress/strain measurements in both directions, nonproportional load paths, sudden changes in load path direction. 2). Novel techniques to excite particular material flow and failure modes such as ductile deformation twinning, shear banding, void growth, brittle compressive cracking, faulting, comminution, granular flow. Characterization of the macroscopic mechanical response of the material during such experimentation is essential.

Phase I: A successful effort will provide a description and analysis of proposed experimental technique(s) addressing one or more of these or related problems. The analysis should indicate that the proposed technique has particular relevance to the above noted concerns.

Phase II: A successful phase II will demonstrate that the proposed techniques are capable of generating useful material characterization data for at least one relevant in the class of materials to which the technique applies.

Potential Commercial Market: This effort is relevant to critical materials characterization and evaluation and is of interest to high-rate forming and machining modeling and simulation.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-150 TITLE: Advanced Lightweight Armor Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative approach to armor design which will decrease weight of helicopter armor.

DESCRIPTION: Helicopter armor weight has been reduced significantly over the past 20 years, however, the need for further weight reduction remains in order that more coverage and therefore more protection can be provided to helicopter aircrews where weight is very critical. The current state of the art armor has evolved through the use of improved ceramics and backing materials laminated together to reduce the areal density or weight of the armor. There are ongoing research programs to attempt to reduce these armor weights even further by varying the ceramics and backing materials through new design or fabrication techniques. A need exists for a research program to be conducted in the area of lightweight armor which addresses innovative approaches to armor design. Some innovative design approaches may be spaced armor design, fluid layers, or use of new exotic space age developments. A detailed discussion of the design approaches to be studied shall be presented along with any fabrication or test data available.

Phase I: Develop armor design concepts which demonstrates potential for substantial weight reduction by utilizing new and innovative material and fabrication techniques.

Phase II: Fabricate samples of the armor design developed in Phase I and conduct ballistic tests to determine if armor shows any potential against specific threats.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-159 TITLE: "More Electric" Advanced Magnetic Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop magnetic materials which possess a minimum energy product of 60 MGOe with minimal hysteresis and eddy current losses, good strength characteristics, and high temperature (200 degrees F) capability. Development of this technology has the potential to reduce the Army's O&S costs by reducing electrical/mechanical replacement costs.

DESCRIPTION: Several studies for military and fixed-wing aircraft indicate that the More Electric approach has the potential for substantial improvements in weight, fuel savings, reliability, severely limiting true benefits of the "electric" approach is magnetic materials. Advanced higher flux materials will increase torque capability while dramatically reducing packaging volume, weight, power required, and cooling requirements in such systems as starter/generators, electromechanical/electrohydraulic actuators, and magnetic bearings for turbine engines.

Phase I: *Develop a magnetic material which will have a minimum energy product strength* of 60 MGOe while exhibiting very low hysteresis/eddy current losses, high physical strength, and high temperature (200 degrees F) capability.

Phase II: The magnetic material in Phase I will be incorporated into a proof-of-concept, high-torque aerospace electromechanical actuator or electrohydraulic actuator, or aerospace generator. The appropriate parameters will be defined. Baseline contemporary materials will be compared to the material under investigation in a parametric analysis. Performance of the magnetic material in the motor will be demonstrated and compared to a baseline system.

Potential Commercial Market: This technology offers enormous potential for various commercial markets involved with electric motors, generators, and actuators.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-167 TITLE: Affordable Development/Rapid Prototyping of Complex Aircraft Components

CATEGORY: Exploratory Development

OBJECTIVE: Develop a design/manufacturing system which can rapidly generate a functional model of an aerodynamic or mechanical component which can be subjected to limited performance testing.

DESCRIPTION: Due to the complexity of modern weapons systems, the time and costs associated with their successful development and qualification are rapidly becoming unaffordable. A revolutionary improvement in affordability could be realized if a prototype model of critical system components could be rapidly produced and subjected to proof testing. Furthermore, the ability to conduct early tests would allow many more iterations of a design to be conducted, thus improving reliability and allowing early incorporation/evaluation of maintainability features. The 3-D solid models available using stereolithography, currently the most popular rapid prototype method, have very poor strength, ductility, surface finish and dimensional stability over time. An advanced process or technique which significantly improves these deficiencies and provides high temperature (150-250 deg F) strength and ductility is desired. Fabrication of the model from ceramics, powdered metals, high-quality photoelastic materials or high-strength engineering plastics would potentially improve some of these limitations. It is desired that these models (scaled or full scale) be suitable for airflow, vibration, and potentially, heat transfer and limited structural testing. For example, scale models of compressor rotors, gearbox housings and structural mounts for electronic

sensors can currently be produced in less than ten hours using stereolithography. Due to the limitations of the model material and the relative accuracy versus the actual part, the model is unsuitable for testing.

Phase I: Develop a design for a rapid prototyping system capable of producing solid models suitable for limited functional testing. The system should be able to utilize geometric data from currently used computer aided design (solid modeling) systems. The system should produce models with strength, dimensional accuracy, and thermal stability signif... above those currently available using stereo lithography. The effect of process variations on accuracy and stability shall be determined. Unique technical aspects of the system design should be demonstrated by bench testing. Results of this testing will be used to evaluate the concept's potential for successful development. Small gas turbine engine components such as cooled turbine blades, compressor rotors/blades along with aircraft structural components such as weapons and sensor installations and environmental control systems installations are of primary interest.

Phase II: A detailed design of the entire rapid prototyping system shall be conducted. A prototype of this system shall be fabricated. Small gas turbine engine or airframe manufactures shall be contacted to obtain trial part geometries. Several different trial parts shall be prototyped and subjected to functional testing. The ability of these tests to reproduce the component performance characteristics shall be evaluated.

Potential Commercial Market: If successful, the technology resulting from this topic would be applicable to a vast array of commercial products/markets. Companies producing aircraft, ground vehicles, gas turbines, internal combustion engines, electric motors, and many other commercial and residential products involving mechanisms and/or energy conversion would greatly benefit. All the major producers of the above products employ rapid prototyping systems to some degree in their current development activities. A system with the advantages to be developed by this topic would allow these companies to drastically reduce the time and cost of bringing new, high-quality products to market. A direct competitive advantage would be gained by companies utilizing this technology.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-179 TITLE: <u>Reduced Weight Power Generation and Air Conditioning Units to Improve Army Mobility</u>

CATEGORY: Exploratory Development

OBJECTIVE: To improve Army mobility without reducing mission equipment.

DESCRIPTION: With the Army becoming more mobile it is essential that the weight of all operational equipment be optimized to allow the use of the smallest possible carrier. The best method for providing power and air conditioning for a mobile operation is to take full advantage of the carrier engine and batteries. This means that the carrier engine should run an air conditioner and a high capacity battery charger system to provide operational power and air conditioning (Army ambulances have such a system). However, in situations where full power from the engine is required by the carrier for transport or in situations where it is not practical or fuel efficient to run the carrier engine, an on-board auxiliary power and air conditioning unit is needed to provide DC power and air conditioning. The DC generator and air compressor could be belt driven to optimize engine size, rating and weight. An electrically controlled hose and valve system should be used to utilize existing air conditioning components, including the evaporator and air handling systems. The shelter power distribution system would be from a common DC buss. This approach for providing on-board power and air conditioning for mobile operations provides equipment redundancy and should assure a high availability for power and air conditioning without having to tow trailer mounted generator sets. It should provide the maximum weight allowance for mission equipment. It would have an added advantage of eliminating separate DC power supplies now required for much of the typical communications equipment and allow the vehicle batteries to be used for an uninterrupted power supply. A 30 percent decrease in the weight and fuel consumption of the APU might be realized.

Phase I: Preliminary design and breadboard testing of the power generation air condition system.

Phase II: Detail design, packaging and fabricating, installation and testing of complete system.

Potential Commercial Market: limited procurement of test quantity and field testing, before type classifying. This effort addresses S&T Thrusts in Advanced Land Combat and the Star 21 focal values of electric drive technology.

OSCR: 1, 4 and 6 Erosion/Wear and Fatigue improvements; Improve the life of components or systems through corrosion/material improvements. New technologies which reduce generator/battery size, improve the efficiency of the power generation/storage system, and/or provide alternate power sources which reduce logistics burdens will be considered under this topic. Fuel Consumption determines the Army's costs for fuel and its distribution. Significant reductions in fuel consumption or policy/procedure changes are needed.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-189 TITLE: Direct Optical Fiber Glass Formation Techniques using Chemically and/or Physically Removable Filamentary Substrates

CATEGORY: Advanced Development

OBJECTIVE: To develop a process for the manufacture of optical glass fiber, and more specifically relates to a novel process in which glass precursor coatings are formed on a continuously moving filamentary core of material which is removed from or becomes an integral part of the ultimately formed optical fiber.

DESCRIPTION: Conventional preforms require complicated processing steps and repeated batch-type handling and increase the cost of the ultimate fiber. Thus, the preform may constitute 75% of the cost of the fiber. Furthermore, since fiber is drawn from a rod of given volume, the length of the fiber which can be drawn is limited. This increases the number of optical couplers and amplifiers needed to connect a number of relatively short segments into a very long signal path. An optical fiber shall be formed by continuously coating a precursor core filament with a glass-forming coatings. The precursor's volatile host shall be continuously moved from a storage reel through a coating station. The filament shall be moved through a stationary glass-forming station and continuously processed to convert the coating to a glass, with the core either removed from the fiber during glass forming or becoming an integral part of the ultimate fiber during glass forming. The glass fiber shall be densified in a continuous process. The fiber shall be provided with a protective coating as it moves through a stationary coating station and the completed optical fiber is continuously reeled.

Phase I: A thorough investigation of state-of-the-art processing for volatile organic fibers or filaments that will allow for sol-gel glass coating to be vitrified on to a volatile host into an optical silica glass fiber having the low optical loss and high mechanical (tensile strength) equivalent to its conventional fiberizable glass preform.

Phase II: Will continue on-going R&D efforts of phase I aimed towards the production and commercialization of low cost optical glass fiber.

Potential Commercial Market: This process shall eliminate the expensive fiberizable glass preforms used in military and commercial applications for communications systems. It will also utilize domestic U.S. materials for processing a non-preform fiber which currently depends on foreign sources.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-225 TITLE: Synthesis of Conducting Polymers for Screening in the Microwave Region of the Electromagnetic Spectrum

CATEGORY: Exploratory Development

OBJECTIVE: Produce conductive polymers which are environmentally stable, non-toxic, and less expensive than those currently synthesized. When used as a military screening smoke, these materials will screen in the infrared (IR) and millimeter wave (MMW) regions of the electromagnetic spectrum.

DESCRIPTION: The Army is looking for a novel way to make conductive polymers as obscurant materials. These materials could be produced by inducing conductivity in off-the-shelf commercially available non-conductive polymers. Currently available conducting polymers (e.g., polyacetylenes or polydiacetylenes) are brittle, not air stable and oxidize rapidly when exposed to air.

Phase I: Would consist of determining existing non-conductive polymers that could be used as a military obscurant for IR/MMW screening and explore methods to increase conductivity.

Phase II: Would produce conducting polymer materials from non-conductive, commercially available precursors by heating in an electrical field to induce conductivity. This process could be applied to a polymer coated metal or non-conductive substrate.

Potential Commercial Market: Proposed commercial potential for the materials include lightweight conductors, battery electrodes, solar cells and semiconductors.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-266 TITLE: Alternative Manufacturing Techniques for MMW Mechanical Assemblies

CATEGORY: Exploratory Development

OBJECTIVE: This project will develop the production process necessary for the development and application of superplastic deformation techniques that are capable of providing the stringent mechanical dimensions and tight tolerances required at millimeter wave frequencies.

DESCRIPTION: Superplasticity is a unique phenomenon of large neck-free elongations. Laboratory elongations as high as 5500% have been reported, although elongations in the range of 300% to 1500% are more common in production applications. Alloys which exhibit this unusual ductility have a very low flow stress are easily deformed in compression. To this date, commercial and military applications of superplastic forming/forging techniques have been limited to making exotic and complicated aircraft structures which require large percentages of elongation. This project has the potential to revolutionize the manner in which small complicated and arduous features such as those found in millimeter wave seeker sensors are produced. This high rate, low cost, production process, once developed, will virtually eliminate numerically controlled machining of mechanical RF components in all Navy, Air Force, and Army missile systems regardless of frequency.

Phase I: The initial phase of this effort will be a producibility analysis of two millimeter wave seeker sensors (one a Ka-Band and one W-Band Seeker Sensor). This producibility analysis will define the mechanical tolerance requirements, surface finish, geometrical shape, and desired electrical characteristics, definition of requirements for the superplastic alloys and lubricant selection analysis of fabrication methods, special tooling requirements, special test fixtures, initial die design, mechanical tolerances and necessary draft angles for ease of release.

Phase II: The second part of this effort will be to develop and establish production processes for the selected superplastic alloys and lubricants. Manufacture "Most Arduous Features" dies based on FEM/AGM analysis and simulation. Manufacture blanking and sizing dies for all seeker sensor elements. Separately manufacture and test all elements of the seeker sensor. Included will be such items as the development of a pilot production line, the design fabrication of prototype production equipment, the development of new production techniques, the development of quality control parameters, and the development of cost schedules.

Potential Commercial Market: Collision Avoidance Radar Modules for aircraft and automobiles.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-268 TITLE: Integration Of Reliability, Maintainability, And Product Life Of Missile Systems With Affordable Technology

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-282 TITLE: Multispectral Camouflage Printed Uniforms

CATEGORY: Exploratory Development

OBJECTIVE: To produce a combat uniform with camouflage properties in at least three areas of the electromagnetic spectrum. The uniform will have a minimum of visual, near-infrared (NIR), and thermal-infrared (IR) camouflage properties, and if possible, will also include radar-absorbent properties.

DESCRIPTION: Current combat uniforms provide camouflage protection in the visible [400 nanometers (nm) and 700 nm] and NIR [600 nm to 900 nm] regions of the spectrum. With the advancement of technology, thermal imagers, radar sensors and multispectral sensors have become an increasing threat to the individual soldier. A means to camouflage the soldier against these sensors must be developed.

Phase I: Phase I will apply a thermal disruptive camouflage pattern, consisting of various emissivities, to a textile substrate. Care should be taken to choose coatings, dyes or pigments that will not interfere with the visual and NIR properties of the uniform. If possible, the thermal IR properties will be integrated into the pigments used to print current camouflage printed uniforms.

Phase II: Phase II will consist of successfully integrating the thermal disruptive pattern with a visual disruptive pattern and NIR camouflage on a textile substrate (such as cotton, nylon/cotton, and Nomex, blends) while complying with a military cloth specification used for combat uniforms. Upon successfully applying the patterns to one textile substrate, the contractor shall work to apply the patterns to other textile substrates used in combat uniforms. Once this is completed, if possible, radar-absorbent properties will also be integrated into the materials. A minimum of 50 yards each of three multispectral materials (best effort) will be furnished to the government, each being on a different textile substrate.

Potential Commercial Market: This technology can potentially be used in clothing for undercover narcotics, CIA and FBI agents. The technology could also be used as a means of labeling objects, such as circuit boards, which are to be examined by thermal imagers for problem areas.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-285 TITLE: Materials and Manufacture Methods for Chemical Protective Gloves

CATEGORY: Basic Research

OBJECTIVE: Develop easily producible gloves that would have enhanced durability and resistance to chemicals.

DESCRIPTION: Due to its excellent low temperature properties and conformability, silicone rubber would be the material of choice for military applications where flex and fit are important for wearability, or where flexibility is essential at extreme temperatures (protective gloves, clothing). Unfortunately, silicone rubbers have very poor barrier properties to chemical warfare agents. Similarly, other elastomers have desirable characteristics for CP gloves, such as fuel resistance (nitrile and epichlorohydrin rubbers), or ozone resistance (EPDM elastomer), but do not provide the necessary resistance to CW agents. Using a process called chemical grafting, it may be possible to modify the surface of elastomeric gloves and thus enhance their chemical resistance. This technique, which could be used as a finishing step in the manufacturing process, involves the attachment of selected monomers with desirable properties to a backbone substrate through the growth of "whiskers". The effectiveness of chemical grafting has been proven through property modification of gloves for medical applications. In addition to chemical protection, it may be possible to improve durability, and also flammability and petroleum, oils, and lubricants (POL) resistance.

Phase I: Phase I will develop a method to modify the surface of commercially available protective gloves, fabricated from a variety of elastomeric materials, and determine mechanical properties and chemical resistance of the modified gloves. A report should include comparisons with the unmodified gloves, as well as with butyl rubber gloves which are currently used for chemical protection (MIL-G-43976C).

Phase II: Phase II will optimize the process and demonstrate the producibility of improved gloves by manufacturing 500 pairs of surface-modified gloves from each of the three most promising elastomers, in each of two sizes and two thicknesses.

Potential Commercial Market: Gloves for protection from hazardous chemicals.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-287 TITLE: Improved Ballistic Protective Material System(s) for Integrated Multiple Threat Protection

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel material technologies for improved, light- weight ballistic protective armor systems for integrated multiple threat protection (fragment, small arms).

DESCRIPTION: Fragmenting munitions are identified as the primary threat to the infantry soldier. However, as the world scenario changes, the type of ballistic protection offered to the individual soldier must be adaptable to a change in threats. Certain Army elements are already specifying upgraded protective requirements and are suffering the penalties of available material systems. Current technologies for small arms defeat are heavy and bulky and tend to be threat specific. Significant advancements in the ballistic protective materials area are necessary to develop a lightweight armor material system to provide protection from high velocity small arms rounds, which can be integrated with improved fragmentation protective items. The goal of this effort will be to improve the capability of the soldier (endurance, survivability, mobility and lethality) through the development of a materials systems that will reduce weight (30%) and minimize bulk over current small arms protective systems and that will provide or can be integrated with current levels of fragmentation protection offered by the Personnel Armor for Ground Troops vest.

Phase I: Identify and investigate novel approaches to increase/improve ballistic protection against a combination of threats, including fragmenting munitions and small arms threats (0.30 cal) with applicability to body armor applications.

Phase II: Produce and optimize selected systems, complete full evaluation (ballistic and environmental), and provide final technical report with full specification for material system(s).

Potential Commercial Market: Improved lightweight armor materials will be applicable to other military armor applications and most certainly to the civilian and law enforcement body armor market.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-289 TITLE: Development and Evaluation of Unique Flame-Resistant, Insulative Battings

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate unique, highly efficient, lightweight, flame-resistant insulative battings for military sleeping bag and cold weather clothing applications.

DESCRIPTION: Presently, the military uses insulation for clothing and individual equipment manufactured from fiber locked (needle punched) aramid fiber when flame resistance is required. However, these materials are heavy and inefficient relative to their insulation performance.

Phase I: Small quantities of one or more unique, flame-resistant, insulative batting concepts in a minimum of four weights will be developed and evaluated. Properties measured will include thermal conductivity, flame resistance, weight, resiliency, recovery, thickness, density, launderability, and wet loft retention.

Phase II: Based on the results of Phase I, the most promising candidate(s) will be manufactured in a minimum of 100 yards in both 2 and 4 ounces per square yard weights. They will also be evaluated for the same properties as in Phase I.

Potential Commercial Market: Civilian applications for cold weather clothing including firefighters, law enforcement personnel, and campers.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-290 TITLE: Biomimetic Ceramics

CATEGORY: Basic Research

OBJECTIVE: Develop an approach to mimic a process leading to the formation of structural ceramics.

DESCRIPTION: A number of studies are ongoing to elucidate the key processes involved in biological systems relative to the formation of crystalline composite materials. Key proteins and proteoglycans have been isolated and characterized. A number of approaches are also being explored to mimic this process using Langmuir systems, miscelles, and solid substrates. An approach is needed to mimic the natural process to lead towards the formation of useful structural ceramics or ceramics with useful electronic or optical properties.

Phase I: Phase I work will involve the choice of a suitable ceramic material for the work, the choice of an appropriate set of organic macromolecules and system to mimic the natural process, and the initial demonstration that useful ceramics or ceramic composites can be generated with the process. Characterization of the materials formed will be essential and must include Scanning Electron Microscopy and X-ray Diffraction analysis at a minimum.

Phase II: Phase II work will involve the optimization of the process demonstrated in Phase I, scale up of the process to produce sufficient quantities of materials for follow-on processing work, processing of the ceramics into a final product or products, and evaluation of the products against similar products formed by traditional approaches to determine benefits. A full evaluation of costs and competitiveness of the process will be required.

Potential Commercial Market: Extensive potential in structural, optical and electronic industries.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-293 TITLE: Smart Membranes From New Polymer Gels

CATEGORY: Basic Research

OBJECTIVE: Identify candidate gels for membranes that have potential in a chemical protective system that responds by contraction during pH changes induced by the presence of chemical agents and water.

DESCRIPTION: Hydrated gels of polymeric ionomers have been shown to expand or contract up to 1,000 times their original volume in response to external stimuli (solvent composition, pH, electrical fields and temperature have been shown to induce dramatic contraction and expansion in gels). Membranes of these gels have never been made, and have potential in a chemical protective system that responds to pH changes induced by the presence of chemical agents and water. The problem is that the contractile gels demonstrated to date are ionomers that must be hydrated. It may not be practical to maintain a hydromembrane in a chemical protective system. The interaction of the gel with the swelling solvent is the key to the critical responses of interest. New polymer gels need to be identified that respond with large density and volume fluctuations to external stimuli.

It is not known how the extent of crosslinking affects the gel's critical phase transition. The importance of the extent of gelation on critical phenomena must be explored.

Phase I: Desired results in Phase I include a) identification and selection of new polymer gels; b) demonstration of membrane construction; and c) evaluation of membrane contraction/expansion properties induced by external stimuli (pH, temperature, electricity).

Phase II: Phase II goals include a) refined membrane construction; b) optimized gel with respect to chemistry, crosslink density, critical gel point (gelation reaction); and c) tested chemical protective effectiveness with respect to temperature, humidity, agent concentration and type via diffusion measurements.

Potential Commercial Market: Health and safety industries and clothing industry (membranes have potential for environmental protection).

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-294 TITLE: Dual-Ovenable, Recyclable High Barrier Polymeric Food Container

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a polymeric food container that is recyclable and reportable, and will provide individual and group military rations with a dual-ovenable reheating capability and a 3-year shelf life. To promote recyclability, the container will be composed of a monolithic material rather than coextruded, multilayered materials. The tray will provide operational and support cost savings by eliminating the trash disposal cost and continuous use of sanitary landfills.

DESCRIPTION: The TMT, polymeric Traypack and 3-year shelf life containers currently under development will partially fulfill Army and Air Force field feeding requirements for shelf stable individual and group meals. However, the reportable high-barrier materials used to construct these shelf stable containers may only be heated by hot water submersion or in microwave ovens, and are not readily recyclable. Also, trilaminate material (i.e., CPET) are commercially available but are limited to packaging frozen foods due to the limited barrier properties. By using new and improved monolithic polymeric blends, a recyclable three-year shelf life food container that may be reheated in a conventional as well as a microwave oven is attainable.

Phase I: Demonstrate the feasibility of developing a polymeric monolithic thermoformed food container and film lid material that is recyclable that will provide dual-ovenable and rations with a 3-year shelf life.

Phase II: Design and develop prototypes of a food container and lid material, and demonstrate the containers ability to be retorted, provide rations with a 3-year shelf life, reheated in both convential and microwave ovens and recycled.

Potential Commercial Market: Commercially available shelf stable foods in coextruded polymeric trays are not dual-ovenable nor readily recyclable. This technology would expand the commercial industry's product line and enhance sales by promoting the new recyclable benefit of shelf stable food containers.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-295 TITLE: Oxynitride Glass Fibers

CATEGORY: Basic Research

OBJECTIVE: Development of High Strength/High Stiffness Glass Fibers.

DESCRIPTION: Oxynitride glass fibers have been shown to have a higher modulus than any other available glass fiber. Laboratory quantities of these fibers are currently available that have a strength and flaw distribution indicative of fibers which may have tensile strengths that are higher than any other available glass fiber. The potential for improved ballistic protection performance of these fibers is thought to be directly proportionate to strength and stiffness.

Phase I: Demonstrate that laboratory quantities of high strength (at least 40% stronger than Englass) oxynitride glass fibers can be produced. Economical analysis of the scale-up operation will be performed under this phase of the program.

Phase II: Scale up production to pilot plant scale operations, and demonstrate strengths at lease 75% stronger than Englass fibers. Limited optimization of the fibers for ballistic impact applications will be conducted.

Potential Commercial Market: These relatively low-cost fibers may be used in composite materials, and in civilian body armor.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-296 TITLE: Ultrasonic Quilting of Insulation Batting Materials

CATEGORY: Exploratory Development

OBJECTIVE: To develop ultrasonic quilting techniques/cover fabrics for military insulative battings.

DESCRIPTION: Currently, insulation batting materials for military cold weather clothing and individual equipment are quilted between two layers of cover fabrics using thread and stitch quilting machines. This process is labor intensive and costly. Also, the stitch holes provide a source for heat leakage and fiber migration through the cover fabric. Additionally, threads can be broken by toe nails contributing to a loss of durability. Ultrasonic quilting should eliminate these deficiencies, but will require compatibility between the cover fabrics and the insulation material.

Phase I: Determine the potential for ultrasonic quilting using commercial patterns or the government offset dumbell pattern. A minimum of four samples will be manufactured by varying materials and processing conditions. The quilted material will be evaluated for thermal conductivity, weight, resilience, recovery, thickness, durability, launderability, wet loft retention, and then compared to standard stitch quilted material.

Phase II: The most promising ultrasonically quilted material configuration(s) will be manufactured in minimum of 100 yard quantities using the military off-set dumbbell pattern. They will be evaluated as in Phase I.

Potential Commercial Market: This system will provide more efficient and economical insulation material for commercial cold weather clothing and sleeping bags.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-297 TITLE: Loaded Semipermeable Membranes for Chemical and Biological (CB) Protective Clothing

CATEGORY: Exploratory Development

OBJECTIVE: To develop and characterize low cost technologies that will enable sorptive and/or reactive media to be incorporated in semipermeable membranes.

DESCRIPTION: Convential semipermeable membrane/fabric systems allow the evaporative cooling process to take place, and prevent liquid and aerosol CB agent penetration; however, a separate sorptive layer, which is bulky and heavy, is required to adsorb chemical agent vapors. This layer adds unnecessary heat stress, weight and bulk to the fabric system. This proposal is aimed at developing loaded semipermeable membranes that offer full chemical, biological, and aerosol protection and are thin, lightweight, durable, low cost and minimize soldier heat stress.

Phase I: Efforts should be focused on demonstrating membrane technologies that can be used to load sorptive/reactive materials in a membrane without inactivating (poisoning) the activated carbon/reactive materials. Laboratory samples will be prepared and characterized.

Phase II: Efforts should be focused on optimizing material performance, the development of bonding techniques to woven fabrics, and the production of pilot plant quantities for uniform fabrication. This material will be bonded to protective shell and liner fabrics. Possibility of commercial-width material production will be addressed.

Potential Commercial Market: This material has potential use in protective clothing in industrial chemical and pesticide contaminated areas.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-299 TITLE: Adaptive Camouflage

CATEGORY: Exploratory Development

OBJECTIVE: Reduce visual detectability of soldier in different climatic areas, and still maintain near-infrared camouflage properties inherent to the current uniforms.

DESCRIPTION: The current combat uniforms provide broad visual camouflage protection in various climatic areas. A need exists to develop a camouflage uniform system that will adapt to different background scenarios within the same climatic area (e.g., meadows, dense brush) as opposed to a forest setting for the temperate woodland pattern Battledress Uniform (BDU).

Phase I: Demonstrate the effectiveness of using photochromic, thermochromic, or electrochromic colorants on a textile material as a means to impart the required color change to match different scenarios without jeopardizing the present durability

and near-infrared camouflage properties. Data resulting from Phase I should determine the feasibility in continuing to Phase II effort.

Phase II: Develop printing patterns using appropriate color combinations of colorants selected in Phase I to design the optimum adaptive camouflage system. Selected patterns shall be printed on sufficient yardage to fabricate uniforms for field testing.

Potential Commercial Market: This technology can potentially be used in clothing for undercover narcotics, CIA and FBI agents.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-303 TITLE: High Energy Laser Material Science Basic Experimental Controls Design

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-324 TITLE: Large Area Passive Broadband Laser Filters

CATEGORY: Exploratory Development

OBJECTIVE: Development of an acceptable approach for a broadband filter for unity vision equipment and the successful fabrication and demonstration of a broadband filter which can be integrated and used with existing unity vision equipment designs.

DESCRIPTION: General - The U.S. Army, Navy, Air Force, and Marine Corps consider the protection of the eyes of military personnel against laser radiation to be a priority objective. The human eye is most susceptible to laser radiation in the range of wavelengths from 400 to 1400 nanameters and must be protected throughout this region. The non-visible portion of this spectral range should be denied access to the eye by fixed attenuation. Transmittance in the region from 400 to 700 nanometers must be preserved to maintain vision under all conditions of illumination. Increasing the number or width of fixed attenuation bands in the visible spectrum will result in unacceptable degradation of the transmittance of visible light through the protective material. New concepts are therefore required. The effort sought in this solicitation is for new technological approaches to protect the eyes of combat vehicle crews, when using unity vision equipment, against emerging multi-wavelength and frequency-agile lasers. The basic desired attributes of a broadband filter usable in unity vision equipment include: capable of being integrated into a unity vision device such that the resulting integrated system has good optical properties, useful durability and ruggedness characteristics, and minimal increase in the unity vision device's bulk and weight, capable of meeting minimum optical density requirements regardless of the angle of incidence of the laser radiation; capable of not interfering with normal color vision and stereo vision; response time for activation of attenuation of less than one (1) nanosecond; recovery time from attenuating condition of less than 0.1 second; visual transmittance-both photopic and scotopic-of at least 50%; capable of functioning without sources of power or input energy other than the incoming radiation; capable of operating without concentration of energy at a focal plane; capable of functioning in temperature extremes (0 degrees to 50 degrees C) and humidity extremes (0% to 100%), resistant to abrasion, salt spray, chemicals, and laser damage; and capable of fabrication in area of at least 100 square centimeters.

Phase I: The contractor shall investigate, design, and provide a proof-of principle demonstration of a broadband laser filter suitable for use in unity vision devices and meeting the requirements set forth in the project description.

Phase II: The contractor shall fabricate and demonstrate the protection approach developed in Phase I. An initial demonstration utilizing the protection approach only may be done, but a final demonstration shall be conducted with the protection approach integrated into the unity vision devices. Requirement: This project is essential for the future development of broadband filters for use in unity vision devices. The lack of a focal plane in current unity vision equipment forces the use of unique and novel approaches in order to meet the developmental and operational requirements.

Potential Commercial Market: The approach developed under this project has potential applications for safety and health equipment needed for ocular welding systems and for optical switching components in communication and computing systems.

OSCR: This project has the potential to reduce optical equipment replacement costs due to the use of a broadband laser filter in such equipment as opposed to filters offering only discrete wavelength protection. Devices with broadband filters would not require refit or replacement as the threat changes or expands, resulting in a lower total lifetime system cost.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-327 TITLE: Subsystem Research - In-Situ Multifunctional Monitoring Systems

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop in-situ systems to monitor the composite material system from material fabrication through disposal.

DESCRIPTION: Emerging combat and tactical vehicle systems are incorporating increasing amounts of composite materials in structural components. Manufacturing techniques for these composite materials are not yet fully matured. Further, once in use in a vehicle, the soundness of the composite structure cannot always be determined visually as damage within the composite material is not always evident on the surface of the material. Such damage generally requires highly trained technicians and special equipment to determine the structural soundness of the composite material. A single system to monitor the fabrication and structural integrity of the composite system must be developed. This single system would be sewn into the fabric preform (fibers), monitor the wetting (or mold fill) of the fibers by the resin (matrix), monitor the cure of the composite part, and provide continuous structural integrity monitoring for the life of the composite part or vehicle.

Phase I: The contractor will conduct a technology assessment of in-situ multifunctional monitoring systems, and expand/develop systems for use in composite vehicle structures. The government will evaluate the research and concepts to determine the potential for use in composite structures. A final report will detail the Phase I effort.

Phase II: The contractor will continue to develop the monitoring systems, fabricate a thick section composite panel with the embedded monitoring system to demonstrate the effectiveness of the design.

Potential Commercial Market: In-situ multifunctional monitoring systems support both military and civilian needs. The Composite Armored Vehicle and potential follow-on production of military vehicles with composite structures require structural integrity monitoring systems. Aircraft (Army, Air Force and Navy) make extensive use of composite materials in wings and other primary and secondary structures. Currently they require extensive laboratory nondestructive evaluation to determine structural integrity, and have no means to determine proper cure of composite parts. The automotive industry is making more and more parts out of composite materials. A method of monitoring fabrication and structural integrity would greatly enhance their use of composite materials by alleviating the liability concerns of using composite materials for primary structures.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-328 TITLE: Adaptive/Tunable Composite Structures

CATEGORY: Exploratory Development

OBJECTIVE: Develop and integrate rheologically adaptive vehicle structures into Composite Combat Vehicles.

DESCRIPTION: Vehicle structures are sized to excessively high loads that occur only a few times during its service life. The result is that these designs are often times very conservative in nature. The loads may be induced by the terrain, collision with trees and other obstacles, or from ballistic events. Development of a structure that reacts/responds to these loads on demand thru the use of rheological fluids would reduce design requirements to a lower level. Damage containment would also be possible since the structure would be designed to react to peak loads. This approach leads to a more balanced and optimized design.

Phase I: Model a rheologically adaptive structure for automotive use and conduct testing to verify the approach.

Phase II: Prototype a given component that will react/adapt to given peak loads without damage. The system would respond to inputs from the Vehicle Integrated Defense System (VIDS) or a system that monitors terrain conditions.

Potential Commercial Market: This technology has application for both the military and the commercial market. It can be used in any structural application where the is a need for vibration dampening, shock mitigation, or load redistribution, such as automotive use or developing/repairing the country's infrastructure (bridges, buildings, etc.)

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-330 TITLE: Joining of Composite Materials

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop new composite joining techniques.

DESCRIPTION: Presently composites are joined by fastening, adhesive bonding or resistance induction welding to form large panels, and to repair damaged panels in field locations. New innovative technique(s) are desired that will improve bonding and field operator efficiency. The joints produced must be sound and result in components with high structural integrity, joint quality and performance. The technique must also be adaptable to field (depot) level use.

Phase I: The contractor will research new techniques for joining composites to form large new panels, and/or repair damaged panels. Techniques developed must be capable of joining composites from a variety of matrices. Such composites are used in several modules, boxes for electronics, and floor beams, trusses, side panels and numerous other structural applications in the auto industry. The technique(s) recommended should allow for the introduction of intelligent manufacturing systems that could facilitate the rapid production of extremely large sized panels/joints at low costs. The technique must also be adaptable to depot level applications.

Phase II: The contractor shall demonstrate the technique developed in Phase I by joining and testing several composite panels. A detailed final report on the joining technique(s) will be prepared.

Potential Commercial Market: Commercial applications for this technique must exist in the automotive, aerospace, satellite, biomedical, and defense industries.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-331 TITLE: Tribological Coatings for Wear Applications

CATEGORY: Exploratory Development

OBJECTIVE: Improve wear resistance of piston rings, cylinders, shafts, sprockets, etc. by depositing an abrasion- resistant coatings on the wear areas.

DESCRIPTION: Current practices improve wear resistance by selectively hardening wear areas in a separate operation after heat treating the base steel substrate to its final condition. By exploiting the growth in novel deposition and coating technologies, incorporate the coating process directly into the heat treatment schedule. Inexpensive diamond, carbide, nitride, boride or oxide wear coating must be deposited by reacting the metal surface with a quenching or tempering media during the base metal's normal schedule. Method must demonstrate the flexibility to produce adherent wear coatings on alloy steel substrates heat treated to a full range of conditions.

Phase I: Evaluate using gases or liquids to react with a predeposited metallic film on hot steel substates to form the hard coat during quenching or tempering, instead of making hardening a separate treatment. Deposition of the metal film prior to reaction should also occur within the normal thermal schedule. Determine what wear coating best meets Army requirements and conduct cost-benefit analysis comparing it to traditional methods like induction/flame hardening and nitriding. Deposit film on suitable substrate and form hard coat by reaction with a gas jet or liquid bath. Final report of findings with recommendations concludes PHase I.

Phase II: Optimize deposition, and head transfer variables to produce strongly adherent coatings. Test wear resistance of coatings and compare with traditional methods. Adapt reaction process and incorporate it into the quench and temper cycle of an alloy steel substrate. Demonstrate coating process and produce coatings for a full range of base metal conditions. Evaluate propulsion applications and determine if any existing specifications can be set by producing coatins in this way. End project with final report summarizing all findings.

Potential Commecial Market: Novel reactive processing of automotive transmission gears and shafts should provide superior wear at low cost. This manufacturing technology benefits agricultural, mining, petrochemical and electronic industries as the principles should apply to numerous substrates and coating types.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-332 TITLE: Subsystem Research - Appurtenance Attachments for Composite Systems

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop systems for attaching hardware ranging from racks and brackets to modular armor to composite structures.

DESCRIPTION: Combat and tactical vehicles typically have all kinds of brackets, attachments and other types of hardware attached to them. In metal structures, bolting or welding these brackets or attachments for brackets is the accepted method. In composite structures, welding (as in metals) is not possible and bolting has its own set of problems (cutting the hole in the composite, the rubbing action of a stressed fastener on the softer composite, etc.). A method or set of methods for appurtenance

attachments needs to be developed that at the least does not diminish the structural characteristics of the composite, and possibly adds to the capabilities of the composite structure.

Phase I: The contractor will perform a literature/vendor search for existing means of attaching hardware to composite materials. The government will evaluate the existing means and determine if any are feasible at which point the contractor will begin to develop the concept for applicability to combat vehicles. If none are acceptable to the government, the contractor will present a variety of potential methods that require further development for evaluation by the government.

Phase II: The contractor will develop the selected method(s) for use on composite materials and also investigate the methods for possible use as hard attachment points (road arms, engine, transmission, etc.).

Potential Commercial Market: With the projected further use of composites on military vehicles, a sound means of attaching hardware to the structure is required. Additionally, in the automotive industry, the move is also towards composites, and they could benefit from the developed attachment means (moldings, fenders, door handles, even hard attachment points). The aircraft industry could also benefit because of the wide variety of lines, cables, etc. that are attached to the inside of aircraft.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-336 TITLE: Self-Healing Primers for Long Term Corrosion Protection of Metallic Substrates

CATEGORY: Exploratory Development

OBJECTIVE: Develop a self-healing primer for long-term corrosion protection of metallic substrates.

DESCRIPTION: Chromium containing pigments are frequently used in corrosion inhibiting coatings for the protection of both ferrous and non-ferrous alloys. Alternatives to these traditional anti-corrosion materials are sought. Develop an environmentally begin pretreatment process to form stable, low permeability, self-healing primer layers over ferrous or non-ferrous metal surfaces. The benefits of a non-chromate corrosion inhibition method for structural metals include reduced workplace health hazards, lower pisposal costs, faster turn-around time and potentially, more environmentally durable metallic structures.

Phase I: Identify materials and processes by which self-healing, damage tolerant coating can be applied to metallic surfaces. Establish feasibility by coating metal substrate and demonstrating ability to heal and continue protecting substrate after damage.

Phase II: Phase II objectives would be to optimize self-healing coatings for specific corrosion prevention applications and to comprehensively test coating system to allow use on military vehicles.

Potential Commercial Market: In addition to paint industries, self-healing primers are a material technology benefitting commercial, recreational, agricultural, and military vehicle producers, ship builders as well as agencies building and maintaining large metal structures such as pipelines, tank farms, refineries, bridges, port facilities and off-shore drilling platforms.

OSCR: Proposed processes lower waste disposal costs, streamline manufacturing operations and reduce necessary worker safety measures by eliminating chronium. Improved corrosion protection offered by these primers would reduce maintenance costs and improve readiness.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-338 TITLE: Flexible Chemical Agent Resistant Coating (CARC)

CATEGORY: Exploratory Development

OBJECTIVE: Develop a CARC capable for use on surfaces having excessive vibrational, rotational or flexible movement.

DESCRIPTION: Current CARC is too inflexible to paint surfaces that have excessive vibrational, rotational or flexible movement (springs, torsion bars, etc.). In many of these cases, coatings and coating systems that provide inferior corrosion protection, as well as no DS2 resistance, are specified for use. By researching and developing a flexible CARC system, the army can increase the protection of the troops from chemical attack.

Phase I: The contractor will research current coating technologies through market surveys and literature searches to determine the feasibility of their implementation and adaptation to the CARC system. The government will determine, based on this research, if there is sufficient grounds for implementation into current and future vehicle systems. A final report will detail the Phase I effort.

Phase II: The contractor will continue the feasibility study of using or modifying commercially-available products for the flexible CARC system. If none exist, the contractor will experiment and develop, using new technologies, a modified flexible CARC system. The deliverables from this phase include a process application guide explaining proper application procedures and surface conditions and a final report.

Potential Commercial Market: An environmentally-friendly, CARC-compatible wood sealant/preservative will suit both military and civilian needs. This technology will insure adherence of the CARC to a wood component used on a variety of combat vehicles and other army and DoD material. Civilian applications include any currently-developed equipment requiring life cycle adherence of a polyurethane topcoat to a wood surface.

OSCR: The army can achieve large cost reductions in the area of component replacement by rendering fewer components susceptible to corrosion, thereby increasing its service life.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-341 TITLE: Lightweight Carbon-Carbon Pistons for High Temperature Engines

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this program will be exploratory work on the design, development, and characterization of Advanced Carbon-Carbon (C_C) Pistons. The C-C pistons developed will be provided to TACOM for engine test bed evaluation. Modifications to the design and improvements in the processing of the piston will result in an optimum design to be used for field evaluation studies.

DESCRIPTION: The need for increased fuel efficiency, decrease in atmospheric pollution, higher operational temperatures in engines, and the requirement for a reduction in overall engine weight and size calls for advanced materials with extended service capabilities. Selected army testing of small high RPM engines has demonstrated the tendency for aluminum pistons to seize with subsequent bearing failures. C-C composites have proven to be excellent candidates for offering unique high temperature properties in addition to light weight to offset these deficiencies.

Phase I: The contractor will research and evaluate current state-of-the-art C-C technology (2D, 3D and 4D) piston designs, coatings, and production techniques; and recommend selection of a specific material and piston size for fabrication and testing in Phase II. A final report will detail the recommended C-C piston size, fabrication techniques, and provide a few demonstration samples. An economic analysis will also be performed for producing a variety of piston sizes.

Phase II: The contractor will design, fabricate, and provide TACOM with two sets of C-C pistons for engine test bed evaluation. The contractor will participate in the engine test bed effort and conduct post test characterization of the C-C piston performance. In addition, the contractor will prepare a detailed final report including all design schematics, experimentation procedures, recommended coating techniques, and characterization results.

Potential Commercial Market: Carbon-carbon composites have applications in automotive, aircraft, and aerospace propulsion industries, as well as small engine manufacturers. These applications include pistons, aerospace structures and heat shields. Fuel consumption will be reduced by 20%-25% resulting in tremendous national savings.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-345 TITLE: Deformable Mirror Device Dynamic Infrared Scene Projector

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop a dynamic infrared projector system for mid and long wavelengths which utilizes deformable mirror devices suitable for integration into hardware-in-the-loop simulation systems mounted on both stable and motion platforms.

DESCRIPTION: Based upon the progression of future smart weapons, imaging infrared seekers/sensors are expected to thrive as a primary technology thrust well into the 21st century. The Redstone Technical Test Center (RTTC) has determined a need for development of a dynamic infrared complex scene projection system. The system is to be used to support post-developmental hardware-in-the-loop (HWIL) simulations for testing and evaluation of infrared (IR) missile seekers/trackers as well as Forward Looking Infrared (FLIR) systems and subsystems in all scenarios. The anticipated operational and support concepts require development, implementation, and maintenance of a simulation system capable of generating and presenting complex multi-color IR imagery. Although deformable mirror technology is available, application of this technology to dynamic scene projection requires significant innovation before becoming acceptable as a viable test capability. Initially, the hardware capability will be demonstrated on a "bench-top" with continued development towards a robust, compact, flight/rate table-mountable configuration.

Phase I: Conceptual design and laboratory demonstration on a stabilized platform of a prototype projector in mid and long IR wavelengths which utilizes deformable mirror devices.

Phase II: Extension and upgrade of the laboratory demonstration prototype deformable mirror projector on a motion platform for use in all-up-round missile HWIL simulations.

Potential Commercial Market: Applications include hardware-in-the-loop simulations of infrared scenes for other defense and commercial uses of infrared sensor technology.

A-2 MICRO ELECTRONICS AND PHOTONICS

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-074 TITLE: Affordable Design of Electronic Structures Incorporating Resonant Tunnelling Elements

CATEGORY: Basic Research

OBJECTIVE: To conduct research on the efficient design of electronic devices and circuits using resonant tunnelling diodes.

DESCRIPTION: To provide for the efficient and affordable design of the next generation of ultrafast devices and circuits, proposals are solicited on the formulation and optimization of charge transport codes and algorithms for the efficient design of electronic devices and circuits incorporating resonant tunnelling diodes as integral parts of basic electronic components. Examples of such devices and circuits include: resonant-tunnelling-diode circuits for the frequency multipliers, parity generators and multiple valued logic, resonant tunnelling bipolar transistors for circuit applications including parity generators, multiple state memory, and analog to digital converters; and resonant tunnelling unipolar transistors.

Phase I: Will include optimization of the basic quantum transport algorithms and identification of candidate devices and systems.

Phase II: Will include design of candidate electronic devices and circuits incorporating resonant tunnelling diodes as integral parts of basic electronic components.

Potential Commercial Market. Research and development efforts under this topic have potential for commercialization in all segments of the U.S. electronics industry focussing on fast, dense devices with feature sizes less than about 500 Angstroms, including but not limited to the devices listed above under "DESCRIPTION" and circuits incorporating resonant tunnelling structures will require techniques and tools for affordable design. Without the tools and techniques identified under this topic it will be impossible to competitively design all of the high-performance devices listed above under "DESCRIPTION". The topic of this solicitation directly supports the DoD S&T thrusts of Technology for Affordability, Global Surveillance and Communications, Precision Strike, Air Superiority and Defense, Advanced Land Combat, and Synthetic Environments.

OSCR: Resonant tunnelling elements require very little power to operate and generate little heat. As a result, they will reduce electronic failure rates and result in systems which require very low power consumption, thus reducing operating costs, providing support for the Army Operating and Support Cost Reduction program.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-083 TITLE: Temperature Insensitive Laser Diode Arrays

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate novel laser diode structures whose output wavelength, threshold and efficiency are less sensitive to operating temperature than conventional laser diode structures. The goal is to produce a diode array that can operate without thermoelectric coolers or other such active methods of refrigeration and still maintain output power and wavelength over a broad temperature range.

DESCRIPTION: General - The cost and weight of military systems utilizing current laser diodes are increasing by the requirement to maintain the diode output power and wavelength within a relatively narrow range over the full milspec temperature range. A new, temperature-insensitive diode is needed to reduce the cost and weight of cooling the diodes.

Phase I: Phase I should result in a theoretical assessment of threshold current density, output spectrum, and slope efficiency vs. temperature for the new structure. Proposed fabrication techniques and material growth methods should be for mass-production of low-cost diode arrays. A sample device, showing the feasibility of the fabrication and growth process, should be built, tested, and then delivered to the government.

Phase II: In phase II, several arrays will be built, tested, and delivered to the government. The testing will include output power and spectral output vs. input power and operating temperature.

Potential Commercial Market: The development of temperature insensitive diodes will have a great impact on the size and weight of military systems that use solid state lasers. This includes rangefinders, designators, laser radar, laser communications, and EO countermeasures.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-091 TITLE: Non-Destructive Optical Evaluation of Thin Layer Semiconductor Heterostructures

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate optical techniques applicable to the non-destructive analysis of thin layer (<200A) semiconductor heterostrucutres. Goals are to non-destructively obtain layer thickness, thickness uniformity, alloy composition, composition uniformity, dopant concentration, and concentration uniformity of the thin layers.

DESCRIPTION: General. Develop concepts for non-destructively providing information about semiconductor thin layer heterostructures composed of GaAs and InP based compounds. These structures are used to fabricate novel devices such as the high electron mobility transistor (HEMT), heterojunction bipolar transistor (HBT), and quantum well laser (QWL) which are critical components in the next generation electronic and opto-electronic systems. The device parameters are extremely sensitive to the properties of the thin layers. Being able to accurately determine these properties will enable one to optimize the device parameters.

Phase I: Should result in an analysis of an approach to non-destructively measure the critical parameters of the thin layers in a semiconductor heterostructure using optical methods. Proof of concept demonstrations of the technique is a requirement and may take the form of theoretical calculations. However, translation of the demonstrated approach must reasonably show to be applicable to an actual measurement system. Selection of a prototype will be made and approaches will be determined which satisfy objectives that are representative of device structures critical to next generation Army systems.

Phase II: A prototype measurement system will be assembled and demonstrated. The system will include optical emission and detection apparatus as well as the software necessary to interpret the data. Documentation should be made by demonstrating capabilities using device structures of interest to the Army.

Potential Commercial Market: Development of a system to non-destructively measure the properties of thin semiconductor layers would be of great benefit to the MIMIC Program which involves the use of HEMTs and HBTs in their integrated circuits for application to next generation high-speed electronic Army systems as well as high speed systems in the private sector. QWLs are evolving into critical elements in fiber optic communication systems that will be used in next generation Army systems as well as system in the private sector.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-093 TITLE: Novel Josephson Junctions for Intrinsic Voltage Standards

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the possibility of utilizing novel superconducting materials (other than those currently in use) in Josephson Junction voltage arrays as primary voltage standards, thoroughly detailing the advantages (e.g. less stringent cryogenic requirements) and disadvantages (e.g. flux trapping) of such an array. The ultimate goal is to design and build a Primary Voltage Standard using relatively inexpensive and mobile closed cycle cryogenic systems.

DESCRIPTION: General - Current primary voltage standards utilizing Niobium-Lead Josephson junction technology are mainly confined to laboratories due to their lack of mobility and need for liquid helium. New ideas for primary voltage standards utilizing Josephson junction arrays made out of novel superconductors are needed in order to lower the cryogenic requirements (to a two- or possibly one-stage closed cycle refrigeration system) and to increase the simplicity/mobility of the system.

Phase I: The Phase I efforts should be a detailed analysis of the use of several different, novel superconductors (both the traditional low temperature alloys and the newer, high temperature superconductor ceramics) for the fabrication of an array of Josephson junctions to be used in a primary voltage standard. The study should include cryogenic requirements, flux trapping difficulties, properties of their Josephson junctions, ease of manufacturability and the difficulties in fabricating a large array of junctions with uniform properties.

Phase II: In Phase II, prototype arrays using the best superconductor candidates as determined in Phase I will be fabricated. The various arrays will be evaluated under actual operating conditions and refined, as necessary, to yield the best characteristics. The array demonstrating the lowest cost, best voltage stability and accuracy and optimum performance parameters will be incorporated into a self-contained, portable primary voltage standard. This system should be capable of mobile field use, that is, it should be easily transportable in an Army calibration van and not require exceptional cooling and/or power requirements.

Potential Commercial Market: Several potential applications include calibration and maintenance functions, not only for high accuracy military needs, but also for the numerous commercial vendors of high precision, voltage standards. The

significance of this effort is demonstrated by the fact that the voltage standard system of which this would be the main component, is a recommended STO (Enhanced Forward Area Calibration).

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-096 TITLE: DC to RF Laser Diode Characterization System

CATEGORY: Advanced Development

OBJECTIVE: Design and produce a DC-RF semiconductor diode laser test fixture that allows simple, unbonded and unmounted device characterization. Envisaged tests to be performed include both light vs. current(LI), and spectral analysis and small signal bandwidth measurements. Fixture will provide both facet optical access and have provisions for surface emission. Projected frequency range of interest is initially up to 10GHz.

DESCRIPTION: Two keys areas, RF optical links and optical signal processing, require the development of fast efficient optical sources and modulators. Routine screening of fabricated laser diodes for bandwidth currently requires specialized bonding and packaging arrangements which are time consuming and delicate to perform. A simple test fixture, using high speed probes and optical fiber access could allow testing of cleaved devices without the necessity to package individual devices. Combining the small signal analysis with simple LI and spectral testing would provide a compact test system for complete and efficient characterization of processed samples. In the case of edge emitting devices optical access to both facets or ends of the fixture would allow flexibility for modulator testing. Eventual development to be able to measure simple integrated lasers, surface emitting devices and very high frequency devices (>20GHz) is envisaged. Eventual development into a stand alone test station is anticipated.

Phase I: Develop a prototype fixture to measure 0.8-1.00 um wavelength edge emitting lasers and modulators. Fixture will be readily fitted to both DC, pulsed and RF sources. High speed detector and appropriate biasing circuits will be included in the fixture. Ability to readily load and align different devices is essential. Assessment and testing of the fixture, possibly at ARL, will be undertaken to ensure accurate and reproducible measurements. No external electronics is expected to No external electronics is expected to be incorporated at this stage.

Phase II: Develop a complete characterization system designed around the components developed in phase I. This will include software control and possible inclusion of dedicated electronics (assumed to be off-the-shelf commercial units- no specific electronic circuit or unit design and construction is anticipated here) such that the unit becomes a stand alone high frequency test station. Additionally, the frequency range of operation should be extended to beyond 20GHz and the wavelength range extended to encompass 1.3 and 1.5um operation. A prototype unit will be delivered to ARL.

Potential Commercial Market: Potential applications for high-speed laser diodes and optoelectronic integrated circuits include phased array radar and digital optical signal processing. The latter includes digital optical interconnect for high speed processor applications. The test fixture and system envisaged will enable faster QA and QC to be carried out upon fabricated devices, thereby simplifying the device development cycle. It is anticipated that such a measurement system will be useful in other areas where semiconductor lasers are employed, such as optical fiber communications and possibly solid state laser pumping.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-185 TITLE: Microelectronic Display (MIDIS) Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop state-of-the-art generic microelectronic display (MIDIS) technology, mountable on printed circuit boards (PCB) via microcircuit package, to record, store, and display fault detection/isolation data and other information.

DESCRIPTION: Advances in technology and diagnostic software permit more accurate built-in-test (BIT) at the PCB and to the component level. However, there is no effective and efficient way of sensing faults and fault location, storing the information and displaying failure and other related system data to maintenance personnel, especially once the failed PCB has been removed from its end item. The MIDIS would provide a direct view, readable nonvolatile indicator for identification/isolation for failed PCBs and components, and display other relevant system data. Other applications may include prognostic monitor (e.g., green, yellow, red), event recorder (e.g., identification of redundant circuit usage/failure) and inventory/logistics system status indicator. Display devices should be lower, minimum weight/size, reliable, reusable, resettable and designed with human factor considerations.

Phase I: Address concepts/designs/breadboards for this display technology implementation. Conduct investigations, technical analysis and trade-offs on microcontroller/memory requirements, display technologies and strategies, power, operator effectiveness versus design concepts and hardware costs, human factors, and effective architecture for hardware/software implementation. Consideration should also be given to different types of information to be displayed and a potential family of devices.

Phase II: Prototype/fabricate MIDIS components having undergone successful test and evaluation and demonstrate on potential MIDIS applications.

Potential Commercial Market: MIDIS display technology would allow lower skill level personnel to effect maintenance remove & replace corrective actions in all types of communications-electronics or automotive equipments without having to use sophisticated and expensive test equipment. In the commercial marketplace, this may foster a resurgence in "do-it-yourself" repair of consumer electronic items and automotive repair.

A-3 SENSORS AND INFORMATION PROCESSING (I.E. COMMUNICATIONS)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-186 TITLE: Very High Frequency (VHF) Helix Antenna

CATEGORY: Exploratory Development

OBJECTIVE: Build an exploratory development model of a short, broadband, electronically step-tuned/structured altered, high performance, VHF shunt-fed, helical monopole.

DESCRIPTION: Military combat vehicles require communication antennas that are both efficient and of small size. In the past, 10 foot monopole and sleeve dipole whips have been used for tactical VHF communications. These narrowband structures have been used from 30 MHz to 88 MHz through the use of broadband matching networks resulting in both poor efficiencies and easily recognized visual signatures. Recent developments in pin diode technology combined with step-tuned structure altering antenna designs offer both increased efficiency and lower silhouette. Essentially, a small, high Q, narrowband helix antenna can be step-tuned across a wide frequency range with very little loss. The purpose of this SBIR is to build and demonstrate this concept.

Phase I: Phase I of the program will be concerned with fabricating the antenna and pin diode structure. Measurements of gain, Voltage Standing Wave Frequency (VSWR), and intermodulation distortion will be made throughout the frequency range.

Phase II: The contractor will build the electronic switches and interface necessary to operate the phase I antenna with a SINCGARS radio.

Potential Commercial Market: Successful demonstration of a low silhouette high performance tactical VHF antenna for SINCGARS radios would provide the U.S. Army, Marines, and other ground forces with a much improved alternate to the present whip antennas. Demonstration of the unique design concept will undoubtedly give rise to new ideas and alternate antennas for many other frequency ranges and applications both commercial and military.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-323 TITLE: Double Focus Unity Magnification Vision System

CATEGORY: Exploratory Development

OBJECTIVE: To design a vision system which focuses the incident light to a small spot within a laser power limiting material and then focuses it again in either the same laser power limiting material or in a second laser power limiting material before allowing the light to exit to the viewer. This system is intended for use in combat vehicles. The system will provide protection against eye-damaging lasers which operate at wavelengths throughout the visible portion of the spectrum.

DESCRIPTION: Because of the expected appearance of multiple-wavelength and wavelength-agile lasers on the modern battlefield, emerging combat vehicles will require laser protection for all wavelengths throughout the visible spectrum. Research is currently underway to develop a protection mechanism which has a high visible transmittance for low input energies, but a very low transmittance to high input energies. Current technologies under investigation do not have the dynamic range necessary to meet the requirements of the Army's unity magnification vision systems. Also, most of the technologies currently under investigation require a focal plane in order to activate the low transmittance characteristic needed to attenuate high input energies. A unity magnification vision system with only one focal plane would be impractical, since the viewed image would be inverted.

Although an erecting prism could be used to re-invert the image for viewing, it is unlikely that this approach would provide acceptable power limiting performance. Two focal planes would most likely be required in a usable unity magnification vision system. Current Army unity magnification vision systems do not have a focal plane at all. The present challenge is designing an optical system which has two focal planes and which improves on the limiting characteristics of the laser power limiting materials. One plausible approach may be to design the system such that the two focal planes are within two separate laser power limiting materials arranged in series. In addition, it is hypothesized that a lower optical switching threshold may be achieved in a system that focuses the incident energy to two spots which are coincident or very close to each other within the same laser power limiting material. Both approaches should be investigated, along with others which the contractor may conceive. The optical system should be designed such that it can be tested with several different laser power limiting materials. The refractive index of most of these materials falls between 1.3 and 1.6. The field of view required under this effort is + 40 degrees (80 degrees total). Overall physical constraints are: height < 16", width < 10", thickness < 4". Emphasis should be placed on high visible transmittance at low energies and a low number of elements.

Phase I: The contractor shall propose optical designs which meet the objectives as outlined above for a double focus unity magnification vision system. The design must not use any ultra-violet curing adhesives (since these degrade over time) and must address lifetime limitations of the system (if any), to reduce the need for replacement of the item after initial implementation. The government will evaluate the proposed design to determine its potential for integration with laser protection concepts and for its use in combat vehicles. The deliverables from Phase I shall include design drawings, a ray trace of the designs provided on disk utilizing a common ray tracing program (provided on disk with the program) and a final report.

Phase II: The contractor shall fabricate the vision system and perform a complete optical analysis of its performance parameters and aberrations. Complete optical and mechanical drawings of the fabricated system shall also be delivered with the vision system along with a final report.

Potential Commercial Market: This device would be ideal for viewing experiments within a test chamber which mat abruptly explode or otherwise emit a large amount of visible energy unexpectedly. In the event of such an occurrence, this vision system would prevent the hazardous high energy light from damaging the viewer's eyes.

OSCR: It is requested that the design not utilize ultraviolet curing adhesives, since these degrade over time, and that the lifetime limitations of the system be addressed in order to eliminate the need for replacement of the item after initial deployment. The current vision devices are replaced every few years. It is the aim within this effort to eliminate replacement costs altogether.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-354 TITLE: Downsized Color Reproduction System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a compact, easily transported color reproduction system capable of producing small quantities of a broad selection of maps, terrain graphics, and other special product images in a demand printing mode at the site of the customer (user).

DESCRIPTION: The Quick Response Multicolor Printer (QRMP), an ongoing development, is being designed to support troops at Division, Corps, and Echelons above Corps HQ in the reproduction of maps and terrain graphics of many types. Once this shelter mounted system is fielded, it will provide some "nearby" demand printing for the user, but the need to have a reproduction system operate with lower echelons of troops in the field will not be satisfied. This SBIR has a goal of identifying suitable hardware and software systems that when housed in a small Army shelter, vehicle, or equivalent, and transported to the field. It shall provide the required demand printing. It will be necessary to identify appropriate scanners, image processing systems, copiers, printers, and software that can be packaged in a small space and at the same time print full color products. The reproduction system must be contained and transported in a suitable shelter and/or vehicle which will protect it from damage caused by the environment or by vibration and shock caused by moving the system across rough terrain.

Phase I: Investigate and identify components and systems that have the potential to meet the requirements of a Downsized Color Reproduction System. Develop a specification for the components and system and demonstrate functionality to establish feasibility.

Phase II: Develop a working model of the system and integrate it into the selected shelter/vehicle. Conduct engineering level tests to prove functionality and environmental durability and provide reports.

Potential Commercial Market: A compact/downsized color reproduction system has high potential for the construction and/or oil-siting industry for quick turnaround products on-site, in the field.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-039 TITLE: Low Cost Laser Radar (LADAR) Technology for Smart Submunition Target Sensing

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate that a low cost ladar system can be completely packaged into a given volume constraint and enter into production at a maximum cost goal. The desired cost, volume, and form factor will be provided. The ladar must autonomously detect, locate, and classify various ground targets in clutter from a SADARM like platform configuration.

DESCRIPTION: Technology Base work conducted at ARDEC with preliminary design LADAR testbeds has clearly indicated the feasibility that LADAR offers a new, high performance, lost cost candidate for improved target sensing of armored vehicle type targets. Testbed devices and a captive flight test system is already in place. The following objectives remain to be demonstrated; tailor and package a specific design to the given application, conduct additional captive flight testing in increasingly adverse terrain conditions, develop and improve the target detecting and aiming algorithms, build an end product prototype demonstration package suitable for demonstration in a weaponized platform, produce documentable production cost engineering to meet end item cost goals.

Phase I: Submit credible design with analytical model predicting performance.

Phase II: Fabricate package, conduct tower testing, conduct captive flight testing, demonstrate improved Pd and Pfa with advanced algorithms, prepare final drop test demonstration.

Potential Commercial Market: LADAR profiling and sensing technology has enormous implication for commercial applications. Because short range LADAR offers extremely high resolution at a low cost, LADAR sensors will have application in the commercial automotive industry. LADAR sensors can be built into standard automobiles to provide automated collision avoidance systems with tremendous implications for automotive safety on a national scale. Combined with other technologies, it can be used for automated position location and navigation, as well as for autonomously driven vehicles. Further applications will be for low cost altimetry in aircraft, automated cartography, aircraft collision avoidance, and high precision automated aircraft landing systems in airports.

OPERATIONS AND SUPPORTABILITY COST REDUCTIONS (OSCR): Future smart munitions based on conventional radar and IR sensors employ extremely high tech, high cost solutions for target sensing with attendant high OSC. On the other hand, LADAR sensing systems are extremely simply, and utilize off the shelf optical front end components for the most part. Because of the simplicity of the hardware, costs of maintenance and training are expected to be significantly less due to its low complexity. Furthermore, because of the high resolution capability of LADAR, the system is inherently capable of recognizing a wide variety of new targets by merely retraining the target recognition algorithms. Future LADAR systems can be readaptable and retrainable to spontaneous combat, target, countermeasure and clutter conditions with extremely short notice. This meets the emerging requirements of the Army that future systems shall be field adaptable to new conditions, especially countermeasure surprise. Field adaptability means quick modification without redevelopement costs and long term cycles.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-044 TITLE: Passive Aero-Acoustic Sensor Self Interference Cancellation

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate practical and effective local acoustic noise cancellation/reduction for acoustic sensor systems mounted on ground vehicle/weapon platforms.

DESCRIPTION: General: Weapon platform and own-vehicle interference tend to degrade passive aero-acoustic sensor performance (i.e. the ability of the sensor system to detect, track, classify, identify, and locate targets). ANC (Automatic Noise Cancellation) techniques such as the classic Widrow algorithm, have been considered for cancellation of such interference, but these techniques in elementary form have not offered the degree of cancellation needed when the weapon platform or own-vehicle is "stationary/operating"; the problem becomes much more difficult when the acoustic sensor system must detect and locate distant threat ground combat vehicle and helicopter targets while operating on a moving ground vehicle ("sense on-the-move"). Innovative practical and effective acoustic noise cancellation/ reduction techniques will be developed. Research should address both stationary/operating and "sense on-the-move" cases. Initially, work should address the simpler case where the acoustic sensor system is mounted on a stationary ground vehicle with engine on, and the weapon platform fire control systems are operating. Examples of approaches to the problem might include (1) ANC with multiple reference sensors and innovative signal processing algorithms, (2) enhance the correlation between interference sources at the signal and reference sensors (model the

interference transfer function), and (3) adaptive spatial beamforming and null-steering in the direction of the interfering sources. Also of interest are development of more robust acoustic sensor signal processing and algorithmic techniques which enhance the ability of the sensor itself (exclusive of any external reference sensors, ANC processing, etc.) to resist performance degradation in noisy environments. This research directly supports Army mission areas: Air-Defense, EMW (such as smart-mines); Close-Combat (Armor self defense, etc.); Fire Support (inc. AFAS, FARV, Fire Support Modernization Plan, Artillery location/counterbattery); IEW.

Phase I: Assess the amount of noise cancellation required for typical weapon platforms to achieve the required acoustic sensor system performance (e.g. target detection, classification, etc.). Define and develop an effective, robust, and practical baseline system for acoustic noise/interference reduction/cancellation for the "stationary/operating" case. Use existing recorded data, and/or conduct measurements of noise field of one or more candidate Army vehicle/weapons platforms. Conduct a computer simulation and/or a laboratory/field test to assess potential performance and technical feasibility of this baseline design concept. Develop system design for canceling/reducing "on-the-move" vehicle noise.

Phase II: Construct experimental noise cancellation/reduction system hardware with appropriate signal processing algorithms using the techniques developed in Phase I. Demonstrate feasibility for effective acoustic sensor system performance for both stationary/ operating and "on-the-move" vehicle operation. Conduct laboratory and or field tests - preferably with the experimental system mounted on an Army ground vehicle/weapon platform.

Potential Commercial Market: A variation of this noise cancellation technology can be used to reduce interior noise levels of automobiles and trucks, and lower noise levels in passenger compartments of commercial aircraft. This technology could also be used to cancel noise in office environments, factory machinery noise, etc.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-047 TITLE: Multipath Interference at Millimeter Wave Frequencies

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop and demonstrate techniques to minimize the effects of multipath interference on millimeter radars and trackers operating in low angle tracking scenarios.

DESCRIPTION: The U.S. Army has been experimenting with the use of Millimeter Wave (MMW) technology to track and guide tank and artillery projectiles. However, experimental beacon tracking systems have been rendered ineffective due to multipath interference. This interference, which is caused by the simulations reception of the direct wave from the source and the waves reflected from the ground, causes tracking inaccuracies. The effect is most pronounced for low trajectories. Until the problem is solved, the use of millimeter waves for tracking and guidance will be limited only to high angle trajectories. This effort will focus on abating multipath interference due to low angle tracking at millimeter wave (at 35 GHZ and higher) over all terrain surfaces.

Phase I: This phase consists of laboratory demonstration of multipath reduction techniques and selecting one which best enhances low angle tracking.

Phase II: This phase consists of a field demonstration of the technique that was selected at the end of Phase I.

Potential Commercial Market: The technology developed under this project can be used to minimize low angle tracking errors due to multipath interference. Aircraft tracking radar performance could be enhanced with the use of this technology, particularly all commercial and recreational aircraft tracking radar. For instance, a commercial aircraft on a final approach to a runway can be monitored and guided by air traffic controllers accurately and without any human interpolation of the aircraft position information.

OSCR: Successfully developed technology will enhance low angle tracking and guidance accuracies and therefore, increasing lethality of all gun fired projectiles. With this capability, newly developed tracker and guidance systems will accurately deliver projectiles to the target. This will reduce multiple fire of projectiles to destroy a target, hence, incurring a significant cost savings.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-049 TITLE: Characterization of Atmospheric Turbulent Effects for Acoustic Transducer Windscreen Design

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate the effectiveness of prototype noise cancelling/reducing windscreen for implementation on smart mine/ground based acoustic sensor system applications.

DESCRIPTION: Background: Acoustic sensing/processing technology offers distinct advantages in battlefield target detection, classification/identification, localization. These sensors operate on non-line-of-sight targets, and are virtually non-detectible because of their passive (non-emitting) operating mode. Improvements in the computational power and speed of microprocessors/DSP chipsets have led to the realization of sophisticated target acoustic emission exploitation capabilities in relatively small, low power consuming packages. Strategically significant targets, such as helicopters and ground vehicles, are characterized for the most part by their low frequency (10-200 Hz) acoustic emissions. This feature makes them particularly well suited to long-range detection in that these disturbances suffer less propagation loss due to ground absorption/impedance effects. Unfortunately, noise produced by local wind turbulents has a characteristic 1/f frequency distribution, which has the effect of masking the most prominent target signature features. Innovative wind noise cancelling/reducing techniques will be developed for implementation on smart mine/ground based acoustic sensor system applications. The research should be geared toward reducing the effects of wind noise on an acoustic sensor located at or near ground level (< .5m AGL). It is desired that the sensor system perform with no degradation in a wind at speeds up to 25 mph. Examples of approaches to the problem might include but are not limited (1) Adaptive noise cancellation using a reference sensor (pressure transducer, microphone, hot-wire anemometer) and innovative signal processing algorithms, or (2) development of improved windscreen geometry or material. This research directly supports Army mission areas: Air-Defense; EMW (such as smart mines); Close Combat (Armor Self Defense); Fire Support (inc. AFAS, FARV, Fire Support Modernization Plan, Artillery Location/Counterbattery).

Phase I: Analysis and design of wind noise attenuation technique/device. Use existing data or conduct field measurements of wind induced acoustic noise. Conduct a computer simulation or laboratory/field test to assess the potential performance and technical feasibility of the design concept.

Phase II: Construct experimental noise reduction/cancellation hardware and/or software. Demonstrate and validate, preferably using a Wide Area Mine mockup, the effectiveness of the device/technique at wind speeds up to 25 mph.

Potential Commercial Market: Useful for commercial applications where wind or other random/non-periodic low frequency noise interferes with the measurement of low frequency signals of interest. Would be valuable in a noise/vibration measurement/analysis/reduction device, or a security/ surveillance/ interdiction system which employs acoustic sensors. Additionally, an improved windscreen would have applicability in consumer electronics (camcorders, etc.), and in the music recording industry.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-077 TITLE: Token Ring Protocols for Packet Radio

CATEGORY: Basic Research

OBJECTIVE: To adapt token ring protocol techniques to single-hop packet radio networks.

DESCRIPTION: The performance of protocols presently used in battlefield packet radio networks is degraded by delaysin radio, terminal and modem equipment. These delays are often so severe that they obviate the benefits of carrier sensing algorithms. Resolving collisions and retransmitting packets result in excessive delays in message delivery, especially under the severest conditions of combat. In addition, slotted Aloha suffers from unacceptably low throughput. On local area networks (LANs) token ring protocols provide a means of avoiding problems associated with packet collisions, but such protocols have not yet been adapted to radio channels. We propose to use silence as the token (permission to transmit). Each user is assigned an arbitrary position in a virtual ring. After a station completes a packet transmission, only the next station in the ring has permission to transmit (i.e., has the token). If that station does not transmit, the following station will wait a prescribed amount of time (which accounts for propagation and equipment delays, uncertainties in knowing the time, etc) after which it will "have the token".

Phase I: Perform design and analysis of a packet radio protocol which mirrors the operation of token ring protocols used in modern LANs. Consider the following: accuracy and resolution with which a node can know the time; the size (in units of time) of the token; effects of timing errors; effects of nodes dropping out of the net or attempting net entry.

Phase II: Conduct experimental demonstration of the token ring packet radio protocol with a minimum of four nodes. Collect sufficient data to validate Phase I analysis and to confirm the effects of errors, network configuration changes, and knowledge of time.

Potential Commercial Market: This communications approach has real commercial potential in developing countries which because of weak infrastructure will require distributed, mobile, multimedia communications. Potential application is reasonable in future communications systems involving "smart" buildings and personal communication devices.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-087 TITLE: Vibration-Insensitive Dielectric Resonator Oscillators and New Ceramic Materials for Microwave Oscillator Applications

CATEGORY: Exploratory Development

OBJECTIVE: Option 1- To minimize the sensitivity of microwave dielectric resonator oscillator (DRO) phase noise to vibration. Initial goal is to achieve a vibration sensitivity level of 10^{-10} /g/axis. In addition, the oscillator must be small and lightweight, suitable for missile and other airborne applications. Option 2 - To develop new ceramic compositions leading to improved performance in DRO microwave applications.

DESCRIPTION: Dielectric resonator oscillators have been shown to be highly stable and very low phase noise microwave frequency sources. On the other hand, very little is known about the DRO's vibration sensitivity, which is very important for many system applications. Because the environment of the dielectric resonator plays such an important role in establishing the oscillator's operating frequency, the mechanical design of the oscillator and its robustness are critical. Option 1 will investigate vibration immune resonant structure for several different operating frequencies. Option 2 of the program is independent of the option 1 and will investigate the possibility of producing new ceramic dielectric resonator materials that improve upon the performance of current materials. This however, should not necessarily exclude non-ceramics. Of prime importance are microwave Q and frequency stability under temperature, static stresses, and dynamic acceleration. A high dielectric permittivity is also highly desirable.

Phase I: Option 1- Identify oscillator's components, finalize oscillator design and establish what factors are most important in order to reduce the DRO's overall vibration sensitivity. Option 2- It is anticipated that the oscillator noise measurement will be made at ARL. The contractor should provide samples of DRO dielectric resonators sized for various microwave frequency bands, i.e. L-band through K-band. Various compositions, to include doping for temperature compensation purposes, shall be explored. Various processing regiments shall also be explored.

Phase II: Option 1- Fabricate and test vibration insensitive DROs. Frequency vs temperature, phase noise and vibration tests will be performed on the oscillators Option 2- Optimize the material compositions and the processing procedures to develop very high Q, environmentally hardened dielectric resonators for the entire frequency spectrum from L-band to K-band.

Potential Commercial Market: All radar systems require low phase noise microwave frequency sources. The phase noise translates to detection of smaller cross-section targets, and/or detection at longer ranges. Environmental hardening will permit achievement of ultra-stable frequencies in compact environments.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-088 TITLE: Synthesis of Materials for Uncooled IR Detectors

CATEGORY: Basic Research

OBJECTIVE: Develop new methods of synthesizing and growing multicompound materials, such as $BaSrTiO_3$, and other ferroelectrics, perovskites or pyroelectrics for use as infrared sensing materials to be used in uncooled focal plane arrays (FPA).

DESCRIPTION: General - The current uncooled detector technology uses ferroelectric compounds which are complex mixtures of perovskites such as barium strontium titanate. The detector elements are fabricated from aggregates of the materials not from single crystals or from crystalline thin films. It is quite likely that if the materials technology were to advance to the point that the elements or perhaps the whole focal plane array (FPA) were to be fabricated from a single well oriented crystal, the performance and uniformity of the FPA would be greatly improved.

Phase I: Phase I should develop methods of synthesis and crystal growth which will yield improved quality materials and perhaps either single crystals or crystalline thin films. At the end of this phase some form of demonstrable result such as material samples, as well as, a process should be presented.

Phase II: The technology of the growth process should be developed into a pilot process suitable for scale up into an industrial fabrication line. Methods of growth should be evaluated and techniques for detector fabrication should be considered.

Potential Commercial Market: It is expected that this project if successful would significantly improve the detection sensitivity of uncooled focal plane arrays. In addition, a successful program could also lead to new fabrication techniques, for the arrays and to new fabrication economies. Additionally, improvements in this materials technology would also impact other related technologies in high temperature superconductors and perhaps also ferroelectric memories.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-089 TITLE: Novel High Frequency Optical Modulators

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate new and novel techniques for optical external modulators capable of modulating very high optical powers up to the millimeter wave frequency range.

DESCRIPTION: Recent advancements in high speed photonics have led the way for a distribution network for microwave signals in newly developed phased array satellite systems. These systems require a high power optical signal modulated in the millimeter wave frequency range which is distributed to multiple transmit/receive modules. Conventional optical modulation schemes involve bulk properties such as attenuation, and electro-optic effects. These are limited in their maximum power capabilities, narrow bandwidths, and suffer from high insertion loss. The need for the distribution of microwave/millimeter wave signals requires modulators based on novel mechanisms such as boundary effects which can overcome the aforementioned deficiencies.

Phase I: Under Phase I, the technology to implement modulators based on novel mechanisms such as boundary effects must be identified. The modulator should be capable of accepting greater than 250 mW of optical power at the input and a dynamic range of 10 dB. Performance issues should address millimeter wave operation, microwave input power requirements, input and output optical coupling using fiber and packaging. Development should also include supporting microwave circuitry for impedance matching and driver circuits.

Phase II: Under Phase II, the final designs will be processed, tested, and packaged. A fully functional test facility should be developed and delivered. This test facility should include high-power laser, photodetectors, attenuators and associated test equipment necessary to perform a demonstration of the modulator's operation.

Potential Commercial Market: Applications include phased array systems for SATCOM-on-the-move and ground-based radar, and distribution networks for commercial satellite (CATV).

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-094 TITLE: Millimeter Wave Sensor Technology for Identification of Friend or Foe (IFF)

CATEGORY: Advanced Development

OBJECTIVE: Identify, study, develop and demonstrate use of novel millimeter wave sensor component/module technology to detect battlefield targets for use in identification friend or foe (IFF).

DESCRIPTION: Advanced concepts for low-cost, compact, sensors are needed for rapid and positive identification of friendly forces. Millimeter wave circuit techniques that are transparent to obscurants and avoid false identification of targets which might employ similar technology, are to be explored. Monolithic/hybrid millimeter wave techniques which permit circuit fabrication on a single carrier, thereby eliminating interconnecting lines, reducing size, fabrication and assembly costs while improving performance, should be given a high priority.

Phase I: Study and analyze techniques and concepts of integrated electronics technology incorporating monolithic and hybrid devices, circuits and modules which would search, detect, and identify battleground targets. A simple proof-of-concept demonstration of the functionality of the experimental device, such as an active circulator, novel antenna array beam scanning not requiring phase shifters and RF distribution networks, planar multimode antenna aperture, and multidimensional imaging. The selection of the preferred design approach of a component/device will be based on satisfying the objectives that are representative of the Army's tactical situations.

Phase II: Design, construct, test, and demonstrate the performance of the sensor utilizing the state-of-the-art components/devices analyzed and experimentally verified under Phase I. The end product should be a functional module, including a final engineering report, which would be suitable for field testing by the Army.

Potential Commercial Market: Millimeter wave components, devices, and modules are needed for various DoD systems under development, such as ADKEM, MTAS, Active Tank Defense, Passive Imaging. Phased array antenna beam scanning and active circulator would be the potential spinoffs for commercial use.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-097 TITLE: Miniature Atomic Clock Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative designs for miniature atomic frequency-standards/clocks. The new atomic clock technology is to provide a higher stability, smaller volume, lower power dis- sipation, and is to cost less than the smallest currently available atomic clocks, i.e., the rubidium cell frequency standards.

DESCRIPTION: General - The state-of-the art of small atomic frequency standards is represented by the small rubidium standards, which are on the order of 1 liter in volume, require about 20 watts to operate at -40° C, and which provide a long-term accuracy of 1 part per billion.Cesium beam frequency standards can provide much higher accuracy, are used in strategic DoD systems, however, their much larger size and much higher cost (=$50K ea.) preclude their use in tactical systems. Advances in laser diode, MMIC and other technologies suggest new approaches to atomic clock design that can significantly reduce the size and cost, while improving the stability.

Phase I: Phase I will explore new approaches to miniature atomic clock design, demonstrate proof-of-concept, and predict through analysis the attainable size, power requirement, lifetime, and environmental sensitivities of the new design.

Phase II: Phase II will develop a prototype of the miniature clock in which the atomic resonator package (the "physics package"), but not necessarily all the associated electronics, shall be miniaturized. The prototype shall be tested for accuracy and stability, especially with respect to sensitivity to military environmental extremes.

Potential Commercial Market: Miniature atomic clocks would impact three major DoD S&T thrusts: global surveillance and communications, precision strike, and technology for affordability. A sufficiently small and low cost atomic clock would find large-scale military applications in C3, bistatic and multistatic radar, EW and navigation systems. Commercial applications would include cellular telephone and other telecommunication base stations, satellite communication systems, and navigation systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-100 TITLE: Ferroelectric Smart Microsensor

CATEGORY: Exploratory Development

OBJECTIVE: Design a miniature device capable of both sensing an environmental change and actuating a response utilizing a ferroelectric film which is compatible with integrated circuits and can be micromachined.

DESCRIPTION: General: Develop new concepts and improve material properties for smart sensors which can both sense a change in either temperature, pressure, or acceleration, and actuate a response to maintain/ compensate device performance stability despite changes in the surrounding environment.

Phase I: Phase I would study various ferroelectric materials to determine the most promising candidate to achieve high sensitivity, be relatively easy to fabricate with the flexibility to alter the material properties by changing the chemical composition. This phase would include a device design study with a simple proof-of-principle fabrication and demonstration.

Phase II: In this phase the material processing steps would be finalized to achieve uniformity, reproducibility, and the ability to easily tailor the material for altering the sensor response. A full prototype microsensor would be fabricated and tested to demonstrate its ability to sense an environmental change and actuate a proportional response to stabilize device performance.

Potential Commercial Market: Army sensor systems are dependent on having stable frequency sources to maintain high sensitivity and accuracy in their sensing ability. The stability of these sources is adversely affected by environmental changes. This project would develop new devices which could adjust to these changes by actuating a response to counter the change and maintain a stable performance.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-101 TITLE: Novel Active High Temperature Superconducting Devices

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabricate and test novel High Temperature Superconducting (HTSC) active devices for use in microwave, analog-based subsystems such as mixers, amplifiers, oscillators and buffers. The principal frequency bands of interest are the X and Ka bands. The ultimate goal is to design an integrated HTSC circuit on a single wafer incorporating all the subcomponents needed for, as an example, an RF front end (RF amp, mixer, LO, IF amp, detector).

DESCRIPTION: General - The present state of HTSC devices is, for the most part, concentrated in passive components. New ideas for active HTSC devices (e.g. fluxonic, flux flow transistors, etc) demonstrating gain and/or rectifying action are needed

to facilitate the construction of integrated front ends. The HTSC materials can be any of the recently discovered ones such as the Bismuth-, Yttrium- or Thallium-based ceramics. Because of their expected end use in fielded systems, the only constraint on the operating temperature is that they function properly at temperatures easily attainable by closed-cycle, single-stage refrigerators (i.e. 40° Kelvin).

Phase I: The Phase I effort should include a thorough study of the current state of the art in active HTSC devices, the advantages and disadvantages of each, and their potential for use in active systems. Also, the fabrication and testing of one or more of these active devices should be demonstrated under a range of frequency, temperature and power conditions.

Phase II: The Phase II effort will incorporate the novel HTSC devices into a functional HTSC RF subsystem. In order to demonstrate the usefulness of active HTSC devices, it is anticipated that this RF subsystem will utilize HTSC-based active devices for low-noise amplification and for mixing. HTSC passive devices will also be incorporated into the subsystem The complete package will include a compact refrigerator of appropriate capacity.

Potential Commercial Market: The potential applications for active HTSC devices include a broad range of radar systems including smart munitions, airborne radar and ground-based perimeter defense.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-122 TITLE: Diffractive Optical Elements for Laser Diodes

CATEGORY: Exploratory Development

OBJECTIVE: There exists a great potential for applications of diffractive optical elements in commercial and military markets. However, for optical processing applications involving laser diodes, two major problems exist. One is the severe chromatic aberration associated with diffractive optical elements and the second problem is the wavelength instability of laser diodes. Design algorithms and fabrication techniques are needed for diffractive optical elements that can tolerate variation in laser diode wavelength without suffering significant loss in performance. To reach Phase III, the objective is to develop a design methodology and corresponding fabrication techniques that produce low cost diffractive optical elements suitable for optical processing architectures that incorporate laser diodes.

DESCRIPTION: General: Design algorithms and fabrication techniques are needed for diffractive optical elements in optical processing systems. These elements must have low f-numbers and high diffraction efficiency. Further, they must be able to cope with the wavelength instability in laser diodes. These algorithms must consider the severe chromatic aberration associated with diffractive optical elements, a characteristic that makes them difficult to use with laser diodes.

Phase I: Development of design algorithms and fabrication techniques for diffractive optical elements specific to optical processing. Phase I will include software development, simulation and identification of fabrication techniques suitable for the proposed designs.

Phase II: Advanced development, fabrication and characterization. Upon successful completion of Phase I, Phase II would include advanced design, fabrication of prototypes, and characterization of performance.

Potential Commercial Market: Technology developed under this SBIR could serve a variety of commercial applications. These include compact disc players, optical disc drives, diode laser printers, and other systems that require optics for laser diode sources.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-123 TITLE: Fast Computation of Iterative Maximum Likelihood Estimator for Continuous Wave (CW) Tone Extraction

CATEGORY: Exploratory Development

OBJECTIVE: Design and build synergistic hardware and algorithms (a box) to extract interference signal that are nearly CW Tones at real-time rates. "Real time rate" means 64K point records (12-bit fixed point) at a rate of 500 per second. "K" is understood to be 1024.

DESCRIPTION: The Army Research Lab is conducting research on ultra wide bandwidth (UWB)radar systems where interference is a problem. The digitized radar echo consists of a stream of 64K point records such that the sustained rate is on the order of 500 records per second. The radar echo is noise-like. Interfering signals, however, are relatively slowly modulated sine waves (slow compared to the radar echo). Preliminary work has shown that an iterative maximum likelihood algorithm does a good job of estimation the interfering sine waves. Once estimated, these sine waves are digitally subtracted from the received records to generate "cleaned" records. The maximum likelihood algorithm was evaluated based on its minimal

reduction of the radar signal energy, its generation of minimal sidelobes, and its large reduction of the interfering signals. ARL needs cost effective computer architectures matched to algorithms to allow real time interference extraction.

Phase I: Design various computer architectures and algorithms. Simulate the performance and characterize the performance versus size, cost, weight and scaleability to extend the performance. Make recommendations based on the tradeoffs.

Phase II: Build a prototype and demonstrate the performance.

Potential Commercial Market: Potential for the active muffler industry, real-time active cancellation of changing acoustical or seismic noise. Real-time process control requiring super-resolution.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-124 TITLE: Artificial-Intelligence-Enhanced Signal and Information Processing

CATEGORY: Basic Research

OBJECTIVE: This topic solicits research in advanced signal and information processing algorithms as well as hardware architectures which will support critical Army program areas such as fusion stations, ground stations, advanced-sensor-based robotics, and automatic target recognition.

DESCRIPTION: ARL/S3I has a strong continuing interest in real-time signal-and information-processing research as applied to single-sensor, multisensor, and multisensor integration (fusion) station processing. Information processing includes those operations normally performed after signal processing, thus relating to higher levels of abstraction and lower "bandwidth" (measured in instructions per second) than those addressed by signal processing. Examples of information-processing tasks include multisensor correlation, fusion, target tracking, situation assessment, target value analysis, etc. Information processing encompasses approaches that are both algorithmic and symbolic (based on artificial intelligence (AI)). Applicable research topics should relate to high-speed signal and information processing (particularly with AI- based enhancement) for such systems as acoustic, radar, and eletro-optics sensors in single and multiple (homogeneous as swell as heterogeneous) sensor configurations. This topic includes advanced processing architectures as well as advanced algorithms.

Phase I: Signal and/or Information processing research yielding innovative algorithms or advanced processing architectures which are then simulated or otherwise shown to have potential in real-time processing applications.

Phase II: Research resulting in the real-time implementation of Phase I algorithms and/or processing architectures which will show direct relevance to an objective interest area such as fusion stations, ground stations, advanced-sensor-based robotics, and automatic target recognition.

Potential Commercial Market: The technologies related to this topic, Artificial Intelligence Enhanced Signal and Information Processing, correspond strongly with a number of commercial or dual use applications such as aircraft tracking and control for commercial airfields or intruder detection and tracking on private locations. The target recognition area relates to identification of individuals and objects for security and robotic parts placement. This also relates strongly to the intelligent highway program that the Department of Transportation is sponsoring.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-125 TITLE: Low Cost, Highly Stable Oscillator Systems

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort will be to advance the state of technology to develop small, inexpensive, rugged oscillators which can be calibrated to obviate the need for highly stable (i.e. expensive) oscillators. This would directly support the precision strike thrust S&T thrust in the area of precision guided artillery projectiles and other low cost ammunition systems.

DESCRIPTION: Systems often require ultra accurate frequency reference or timebases. Tactical systems can not afford the cost of high grade frequency sources, nor the time required for temperature stabilization of a frequency source, since they are often powered at launch. One example would be a Global Positioning System (GPS) receiver, which requires a precise time reference, mounted on a rocket. The performance of a low cost oscillator may be acceptable if it can be calibrated at or immediately after launch. This topic area is looking for innovative solutions to calibrating an unstable oscillator. A GPS receiver would be an adequate system to base the study on, in that once the receiver has acquired the GPS signal, the precise frequency of the satellite is available, but the acquisition cannot take place without an accurate frequency reference. Both tethered (pre launch calibration) and unconnected (powered at or after launch) systems should be considered. A Phase I effort resulting in algorithms and a system study could lead to a Phase II effort consisting of a test of actual prototype hardware.

Phase I: An investigation shall be conducted in small, inexpensive oscillator technologies which can be used in place of highly accurate oscillators and report on potential candidate systems.

Phase II: Continue detailed studies into small, inexpensive oscillator technologies which can be used in place of highly accurate oscillators, etc. and demonstrate candidate systems.

Potential Commercial Market: The systems developed under this effort would be applicable in products that have a short use lifetime yet require a high quality oscillator, such as expendable GPS receivers for weather balloons, radiosondes or sono-bouys.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-126 TITLE: Charge Coupled Device (CCD) Evaluation using the Modulation Transfer Function (MTF)

CATEGORY: Basic Research

OBJECTIVE: Develop an automated minimal error MTF test system for 1-D and 2-D CCD arrays

DESCRIPTION: Develop a system and procedure to evaluate CCD arrays by measuring the modulation transfer function. The operation should be automated to the extent that no manual handling of the array output data is necessary. Instrumentation and software capable of gathering the data, performing the required spatial domain processing, and displaying the results are required. The hardware and method chosen should minimize the effects of any optical aberration and phase dependence between the optical source and the array. The MTF should be measured over a frequency of zero to Nyquist and be separable from the arrays fixed pattern noise. Array sizes are up to 1x1024 for 1-D and up to 1500x1500 for 2-D. The CCDs should be tested at wavelengths from visible to 830 nm.

Phase I: The Phase I effort will include a feasibility study, discussion of possible solutions, and selection of a testing system which minimizes component ... .. Following the selection process a prototype will be built and characterized.

Phase II: The phase II effort will be the refinement of the above prototype into a deliverable test system.

Potential Commercial Market: Manufacturers of equipment containing CCD arrays may be interested in using this evaluation to characterize the arrays.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-127 TITLE: Two-dimensional Individually-addressable Laser Diode Arrays

CATEGORY: Basic Research

OBJECTIVE: The ability to randomly address individual elements of a two-dimensional laser diode array is required in incoherent optical processors where the laser diode array is used in the object plane of the processor. To be competitive with digital image processing schemes, high resolution arrays with 1024 x 1024 elements are necessary. A matrix-addressed array would require 2048 connections to the outside world. Such a large number of connections is impracticable. In addition, the matrix-addressing scheme is limited in its ability to access sets of elements. Clearly, more flexible addressing schemes must be explored. A two-dimensional individually-addressable laser diode array would find potential applications in incoherent optical processors, optical morphology, displays, and free-space optical interconnections. To reach Phase III, the objective is to develop a two-dimensional laser diode array whose elements can be individually addressed. Possible addressing schemes include but are not limited to integration of the laser diodes with on-chip shift register and multiplexer circuitry or optical-addressing via acousto-optic scanners or spatial light modulator devices. The device should show scalability to 1024 x 1024 elements, have an optical intensity modulation with 24 dB of dynamic range, and have the capability for operation at kHz frame rates. Consideration should also be given to integrated packaging with microlenslet arrays for flexibility in formation of the output beam characteristics.

DESCRIPTION: Incoherent optical processors require object plane arrays with the temporal coherence available from laser diodes. A two-dimensional laser diode array must have elements which are individually-addressable for the display of random input images.

Phase I: System design and development. Phase I will include the identification and design of the addressing scheme for a two-dimensional laser diode array. The design must include selection of the laser diode configuration and its method of integration with the addressing network. The performance characteristics of the device also must be addressed in Phase I.

Phase II: Advanced development and testing. Develop and demonstrate a prototype device with at least 64 x 64 elements. Deliver prototypes for testing at ARL.

Potential Commercial Market: Two-dimensional individually-addressable laser diode arrays span a broad range of potential commercial applications which include high resolution miniature displays, solid state barcode scanners, optical communications, and assembly-line quality control. The compact lightweight nature of the device should form a rugged package capable of surviving the harsh environments of the commercial market place.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-128 TITLE: Wideband Frequency Selective Limiter

CATEGORY: Basic Research

OBJECTIVE: Develop a wideband frequency selective limiter for ESM applications.

DESCRIPTION: Develop a frequency selective limiter capable of attenuating overpowering narrowband interferers (bandwidth less than 100 kHz) over a 1 GHz passband. While interferers are greatly attenuated (60 dB), all other desired signals pass through with negligible effects. It is desired that multiple interferers can be attenuated without prior knowledge of their location in the spectrum. This device should also exhibit a 60 dB spurious free dynamic range, minimum insertion loss (less than 10 dB), and minimum ripple (less than 1 dB). Other desired features are small size, weight and power consumption.

Phase I: A Phase I effort should consist of a technology study to determine the feasibility of a frequency selective limiter with the above characteristics. With such technology limitations, what best effort can be achieved? Two prototypes of the selected design should be assembled with measured data and delivered.

Phase II: A Phase II effort should concentrate on extending the frequency selectivity bandwidth and dynamic range not achieved in Phase I. Improving insertion loss and ripple, and minimizing size, weight, and power requirements is desired.

Potential Commercial Market: The requirements for commercial application is to use wider modulation bandwidths and less transmit power in their radar and communication equipment. This is driven by cost savings of less transmit power. This also causes the potential of narrowband co-located transmitters to interfere with wideband equipment. The requirement for wideband frequency selective limiters is to suppress narrowband interferers without distorting the entire modulation bandwidth. Additional benefits would come from a device that exhibited a small size, light weight, low cost in production, and interference rejection without apriori information.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-129 TITLE: Foveal Vision Algorithms

CATEGORY: Basic Research

OBJECTIVE: Develop algorithmic techniques for ATR using foveal vision analysis on second generation FLIR imagery in order to reduce computational load and increase performance.

DESCRIPTION: Foveal vision incorporates multi resolution analysis of an image using low resolution wide field of view searching with narrow field of view, high resolution target recognition simultaneously.

Phase I: The contractor will present an analysis of different foveal patterns examined for suitability for various military scenarios, including but not limited to ground to ground, air to air and ground to air. The contractor will also keep in mind that any foveal system should use current detector technology, preferably second generation IR focal planes. The contractor should also address the method of saccade generation needed to direct such a foveal system such as; physical movement of the detector or an electronic saccade moving the high resolution region on the detector chip.

Phase II: The contractor will develop and deliver for testing the algorithmic techniques to demonstrate one or more foveal ATR systems chosen by the government from the Phase I study. Potential Commercial Market: Foveal algorithmic techniques could be applied to any imaging system to speed identification of objects of interest and reduce computational load (i.e. autonomous robots, industrial vision, aided surveillance, etc.)

Potential Commercial Market: Foveal algorithmic techniques could be applied to any imaging system to speed identification of objects of interest and reduce computational load (i.e. autonomous robots, industrial vision, aided surveillance, etc.)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-130 TITLE: Neural Based Automatic Target Recognition (ATR)

CATEGORY: Basic Research

OBJECTIVE: Develop neural network based ATR modules to improve performance and/or speed of the ATR process.

DESCRIPTION: Neural networks are capable of a number of functions important for ATR development including classification, pattern matching, pattern completion and noise removal. These functions are often faster, more robust, or more accurate than the algorithmic methods used in common ATR's under development.

Phase I: The contractor will demonstrate and deliver for testing the neural components of an ATR using second generation Forward Looking Infrared (FLIR) imagery, alone or in a Multi-sensor suite, such as but not limited to FLIR-MM wave radar or FLIR-laser radar.

Phase II: The contractor will develop and demonstrate and deliver for testing a complete ATR system using the neural components developed in Phase I, either in a conventional ATR or a completely neural based ATR using the FLIR or multi-sensor information used in Phase I.

Potential Commercial Market: Techniques and alogirthms developed could aid the Medical Imaging Community. Also potential applications exist in machine and robotic vision (i.e. part history and identification) and aircraft and automotive environment sensing.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-131 TITLE: Two-dimensional Optical Signal Processing Architecture and Components for Planar Optics

CATEGORY: Exploratory Development

OBJECTIVE: The development of two-dimensional (2-D) optical signal processing architectures in a planar optics format would greatly improve the manufacturability and robustness of the processor. Here, "planar optics" refers to the arrangement of the optical components in a single plane which communicate by transmission and reflection in a transparent substrate. Examples of candidate signal processing architectures include image processing, 2-D correlation and convolution, and synthetic aperture radar processing. To reach Phase III, the objective is to develop the components and integration methodology for the fabrication of a generic planar optical two-dimensional signal processor. Primary consideration should be given to ease of manufacturability. Reduction of processing steps in the fabrication and compatibility of the individual components is essential. Additionally, to be competitive with 2-D digital electronic processors, the pupil plane element should show scalability to 1000 x 1000 pixels and kHz frame rates

DESCRIPTION: Coherent bulk optic 2-D signal processors are limited in manufacturability and robustness by the critical alignment necessary for the optical comments. A planar optics geometry has the potential for utilizing the mature planar processing techniques currently available from the semiconductor industry. Epitaxial lift-off and flip-chip bonding are two potential techniques for integrating 2-D active optical elements such as laser diode arrays, spatial light modulators (SLMs), and CCD detector arrays onto a common substrate.

Phase I: System design and development. Phase I will include the identification and design of a generic signal processing architecture for concept demonstration. The flexibility of the generic system hinges on the selection of the component elements such as the SLM and diffractive lenses as well as on the integration technique(s). These issues in addition to performance characteristics of the generic system must be addressed in Phase I.

Phase II: Advanced development and testing. Develop and demonstrate multiple element integration towards complete system integration. Deliver prototypes for testing at ARL.

Potential Commercial Market: The driving motivation behind "planar optics" is the manufacturability of robust two-dimensional signal processing systems. Low cost, robust optical pattern recognition systems will find commercial applications in assembly line quality control and machine vision for industry automation.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-132 TITLE: Gun-rugged Accelerometers and Vibratory Gyroscopes

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort will be to advance the state of technology to allow low cost guidance systems for artillery projectiles to be developed. This would directly support the precision strike S&T thrust.

DESCRIPTION: If it were possible to build accelerometers with sufficient accuracy, resolution and range, then both the large forces (> 16,000 Gs) experienced by an artillery projectile during gun launch and the much smaller forces experienced during flight could be measured. By combining these data with the gun coordinates and orientation, the projectile's trajectory would then be fully determined. In addition, the existence of such accelerometers would make inexpensive inertial reference units possible for guided projectile applications. Because the research done to create such ideal accelerometers has shown little progress, it seems unlikely that the necessary technology will emerge in the near future. However, an alternative approach may be possible, one which takes advantage of the Global Positioning System (GPS). To be specific, it may be possible to protect a sensitive low-dynamic-range accelerometer during the gun-launch interval using caging methods or temporary restraining structures such as electrically-fusible links. Although launch acceleration would not be measured, the initial attitude could be accurately inferred and subsequent changes in attitude would be used for GPS receiver aiding. It should be noted that the basic scheme is not new. Various Global Positioning System (GPS) location-mapping devices are now available as options in certain luxury automobiles. Some employ micro-machined accelerometers or inexpensive, rate-integrating vibratory oscillators (vibratory gyroscopes) to estimate vehicle motions during intermittent periods when GPS satellite signals become blocked by structures or terrain. As the first step in an innovative research effort, it is suggested that existing devices be investigated to ascertain gun-ruggedness.

Phase I: Perform analyses and evaluations to determine the accelerometer and gyroscope technologies best suited to produce low-cost devices which will operated after gun launch (17000 G) acceleration.

Phase II: Continue detailed studies into small, inexpensive accelerometers, gyroscopes, etc. and demonstrate hardware suitable for the gun-launch environment.

Potential Commercial Market: The potential commercial market for micromechanical inertial measurement units has been estimated at 20 million units per year. applications in the automobile industry include airbags, breaking, leveling, true skid detection, and augmentation to vehicular GPS navigation systems. Additional commercial application can be found in products such as camcorders, general aviation, medical electronics, and perhaps one of the largest areas of all, children's toys. (Source: Poth, T. Elwell J. "Progress on Micromechanical Inertial Guidance System", 21st JSDE for Guidance Navigation and Control.)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-133 TITLE: Miniature Charged Coupled Device (CCD) Driver-Controller

CATEGORY: Basic Research

OBJECTIVE: To package a high density CCD driver-controller exhibiting small size, high signal isolation and good thermal dispersion properties.

DESCRIPTION: Develop a method for miniaturization and packaging of analog and digital hardware used to control and drive 1024 by 1024 CCD arrays. System must provide a high degree of isolation between high speed, high voltage CCD drive clocks (10-15 MHz) and multiple low noise high impedance analog signals. System must also be capable of buffering these analog CCD outputs for coax transmission. The system must provide a sufficient method of heat dissipation in a high density package.

Phase I: Examine existing CCD control-drive systems. Do a technology study of alternative methods for size reduction and determine what degree of reduction is possible and what the trade offs are.

Phase II: Design, build and characterize a prototype unit for application insertion. A performance appraisal will be based on improvements to an existing controller-drive system.

Potential Commercial Market: High speed, high resolution CCD cameras, and imagers.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-134 TITLE: High Frame Rate, Snap Shot Infrared Imaging Focal Plane Array

CATEGORY: Exploratory Development

OBJECTIVE: To develop, test, and fabricate a high frame rate infrared (ir) focal plane array (FPA).

DESCRIPTION: A high frame rate long wavelength ir imaging FPA that acquires images in a snap shot mode. The FPA should acquire images such that all pixels are irradiated and integrated simultaneously for the same time interval. The pixels

should then be read out simultaneously while the FPA is electronically shuttered. Current long wavelength ir FPA technology uses architecture which reads out pixels serially through a common read-out register. With this type of technology, some pixels continue to be irradiated while others are read out; thus smearing the image of a rapidly moving object.

Phase I: During this phase the effort should propose one or more read out architecture designs for an 8-12 micron FPA micro chip containing a minimum of 128x128 (256x256 desired) square pixels with a simultaneous pixel read out at 1,000 Hz frame rate. The FPA should have a D* of 3x10 *10 cm, a minimum dynamic range of 8 bits (12 bits desired), a responsivity uniformity of 5% for 1/4 the array's area about the center of the array, and a responsivity uniformity of 10% for 1/2 the array's area about the center of the array. The FPA micro chip should include external synchronization and external computer control of the start, stop, and reset functions.

Phase II: In this phase the effort should include the design of, fabrication of, and detailed test plan for demonstrating a prototype 8-12 micron FPA with the specification called out in phase I. Detailed test plan and supporting calculations should address these specifications.

Potential Commercial Market: The potential is very high. A camera with this FPA can be used in the medical field to study and analyze neuron activity in response to stimuli. A camera with this FPA can also be used by industry (especially automotive, aviation, and ship building) to analyze high speed motion of motorized components, turbine blade heat build up, thermal propagation and shock waves, laser annealing and damage, and integrated circuit (IC) inspections. In the chemical field, the FPA can be used to analyze violent chemical reactions.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-135 TITLE: UWB Antennas

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility of an efficient, Ultra Wide Band (UWB), high input drive signal antenna, and the most practical technique to characterize this UWB antenna.

DESCRIPTION: Presently, there are various off the shelf antennas which meet some of the requirements in the UWB community. In recent years, the need to develop an efficient antenna with a bandwidth to cover from 50 to 1000 MHz and to handle input signals of more than 10 to 20 kv has arisen. This effort should focus on the design and development of an antenna with the above mentioned characteristics, and also restricted in size by the physical dimensions that will still allow the antenna to have such a broad bandwidth. Other critical characteristics for this type of antenna are its beam width and input impedance. The beam width parameter should be within the range of plus and minus 15 degrees and plus and minus 40 degrees, and the input impedance approximately 50 ohms.

Phase I: During Phase I, the effort should propose one or more designs for an antenna which can satisfy the above mentioned characteristics. This proposal should also include a formal plan on how to perform the antenna characterization.

Phase II: During Phase II, the effort should include the final design and fabrication of the antenna, and the conduct of the antenna characterization to include the data analyzed and processed defining all parameters of interest.

Potential Commercial Market: These antennas have the following potential commercial applications: 1. Provide U.S. companies an added capability for bidding on mine-clearing operations in areas such as the middle east. 2. Performance of EMC/EMI testing of final products in near to real-time on assembly lines. 3. As an aid to the mining industry for ground recognition in case of accidents, where additional information is needed when searching for survivors. 4. With proper filtering as part of general purpose communication systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-147 TITLE: Machine Health Monitoring with Multi-Domain Smart Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate highly reliable diagnostic system which eliminates unwarranted component replacements.

DESCRIPTION: The removal and replacement of good components based on poor diagnostics is a major contributor to high operation and support costs. Many diagnostic systems are built around the monitoring of a single parameter. This type of system is prone to false alarms and consequent removal/replacement of good parts. New and emerging technology can be combined to greatly increase the reliability of a diagnostic system and avoid the false alarm problem.

Phase I: Selection of machine or sub-system to be monitored, parameters identified, algorithms defined, conceptual model developed, validation plan prepared.

Phase II: Fabricate and demonstrate system for chosen application.
Potential Commercial Market: Aircraft sub-systems, shipboard machinery, plant equipment.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-148 TITLE: In Situ Fatigue Life Monitor

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate an integrated solid state device to measure component strain and calculate (rainflow cycle counting and Miner's cumulative damage algorithms) and display fatigue life expenditure. The application of this technology would increase the useful life of fatigue critical components, thereby reducing replacement costs.

DESCRIPTION: The Army has recently funded efforts toward development of solid state strain sensors and of integrated fatigue life calculation/display systems. A highly desirable extension of these efforts would be a completely integrated solid state device for measuring operational strains and calculating/displaying fatigue life expenditure. A totally self contained unit, including power, is desirable. Current technology should allow for a production unit about the size of a quarter.

Phase I: The initial effort will involve demonstration of strain measuring and logic capabilities of the selected solid state technology as well as preliminary design of an integrated system.

Phase II: This effort will involve detailed design, fabrication, and laboratory demonstration of a brassboard system.

Potential Commercial Market: The useful life of any limited fatigue life commercial aircraft part could be extended by monitoring actual fatigue strains. The potential commercial market for this technology is large.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-180 TITLE: Low Cost Electric/Electronic Governor for Small (5-20hp) Diesel Engines

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low cost electric/electronic governor for small (5-20hp) diesel engines used on generator sets.

DESCRIPTION: The Army is currently replacing its extensive inventory of small (1 1/2-10 kW) gasoline engine driven generator sets with diesel engine driven sets in order to remove gasoline from the battlefield and comply with the one fuel forward policy. Though all small diesel engines have a mechanical governor, it is sometimes necessary to replace these with a more precise governor. There are electric governors available, but they are designed for larger engines and are expensive when compared to the cost of a small diesel engine. A low cost electric/electronic governon needs to be developed that will meet the Army's small generator set requirements.

Phase I: Preliminary design and breadboard testing of the electric/electronic governor.

Phase II: Detail design, fabrication and testing of the electric/electronic governor. Application to an appropriate generator set to validate the design concept. This effort addresses S&T Thrusts in advanced land combat and the Star 21 focal values for electric drive technology.

Potential Commercial Market: Potential to replace mechanical governors on small diesel engines.

OSCR: #4 New technologies which reduce generator/battery size, improve the efficiency of the power generation/storage system, and/or provide alternate power sources to reduce logistics burdens will be considered under this topic.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-182 TITLE: Soldier's Radio: Innovative Communications and Networking Technologies for the Individual Warrior

CATEGORY: Advanced Development

OBJECTIVE: To provide the Soldier/Warrior with a personal communications and robust networking capability by leveraging advances in the Personal Communications Services (PCS) field and developing military-unique technologies.

DESCRIPTION: Requirements for The Enhanced Integrated Soldier System (TEISS) call voice and data communications for the individual soldier and a robust network for the squad and platoon by FY2000. This is also a key element of DoD Science

& Technology Thrust-8: "Sharpening the Warrior's Edge." The Soldier's Radio electronics will likely be on a card embedded or inserted in the Soldier's Computer and will utilize the computer's CPU, RAM, Mass Memory, display, and power source. While the precise frequency band has not been determined, it is expected to be above 900 MHz. Key technologies for this contract will include: security, power conservation techniques, network topology/hierarchy, protocols, voice/data contention, adaptive power, range extension in varying terrain, data relaying for range extension, adaptively modifying network base on dwindling power sources, and interfacing/interroperability/internetworking with other radios/networks. Offerors should assess which technologies and techniques can be leveraged and which will require unique focus under this contract. Offerors should contact DTIC for information on "Soldier's Radio". Offerors, or their team members, must show the capability to transition this work into both DoD and commercial products.

Phase I: Assess current technology and coordinate with related DoD programs. Work with DoD users to refine requirements. Develop comprehensive concepts for technologies to fulfill requirements. Submit Phase II proposal. Define Phase III plan for marketing Phase II results to DoD and commercial markets. Secure Phase III funding prospects.

Phase II: Develop proposed technologies and conduct a system level proof-of-principle demonstration utilizing developed, leveraged, or surrogate hardware/software and/or simulation. Propose Phase III follow-on development. Lay groundwork for Phase III development and DoD/commercial marketing.

Potential Commercial Market: This system has the potential for fulfilling the anticipated commercial demand for robust networking capabilities for PCS devices utilized by teams of mobile individuals.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-183 TITLE: Soldier Audio Orientation and Integrated Command, Control and Communications System

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate lower echelon knowledge technology to enhance soldier awareness and performance in a battlefield environment.

DESCRIPTION: The feasibility of conducting "hands free" command and control for lower echelon operations has been demonstrated recently in laboratory prototype tests. Similarly, advanced prototype communications soldier-machine interface devices have been demonstrated to continue to function in noisy and confined environments. Further technology development is required to integrate the communications with the command and control input and output devices to evaluate the effect of diminished audio cues when working in a hostile battlefield environment. Using lower echelon knowledge, command and control, and communications technology demonstrate the means for restoral of normal soldier interfaces to enhance typical mission functions to include: tactical situation assessment, communications, command and control, planning, status and location reporting, reconnaissance, well-being, and training.

Phase I: Formulate and define conceptual integrated designs that accommodate simultaneous and combined functionality, including hardware implementation and software prototyping, to demonstrate enhanced soldier performance when using linked knowledge and acoustic resources.

Phase II: Develop and prototype a field demonstrable integrated system that has optimized the lower echelon command and control, communications, and situation awareness interfaces for "hands free" operations on-the-move in a hostile battlefield and contaminated environment.

Potential Commercial Market: The primary market for this technology development is the military. Civilian market opportunities exist for operations in hazardous environments where protective suits may be employed.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-184 TITLE: Soldier's Computer Concepts in Maintenance and Logistic Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop applications which utilize Soldier's Computer concepts and technologies for use in maintenance and logistics support operations.

DESCRIPTION: The Soldier's Computer program being developed at CECOM will provide soldiers with a state of the art integrated communications and information processing capability consisting of a shirt pocket or belt mounted computer, miniaturized head mounted display, voice recognition input/output (I/O) control system, and communications radio subsystems. Many new logistic applications of this technology are envisioned for field and depot use. This technology can be adapted for

shipping, transportation & packaging applications, training applications, stockroom parts/supply applications, large scale indoor/outdoor warehousing & inventory & materiel tracking/location/identification applications, and others.

Phase I: Conduct a feasibility study to identify and examine various candidate applications for utilization of the Soldier's Computer concepts and technologies. The study should examine available hardware/software products, system architectures, system costs, technical and technological risks, human factors, and environmental considerations. The study should propose one or more candidate applications for further development and detailed evaluation.

Phase II: Design, develop, and fabricate a prototype demonstration system that can be used to conduct test and evaluation activities and demonstrate system feasibility, utility, and worthiness for the candidate application.

Potential Commercial Market: This technology can support both military and commercial needs. The private sector must provide similar support services for products it sells in the commercial marketplace. Consequently, any applications successfully developed for military application will have similar or identical application in the commercial sector.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-187 TITLE: Advanced Video Compression Techniques

CATEGORY: Advanced Development

OBJECTIVE: Evaluate recent advances in video compression technology for transmission of both near full-motion and still color images of varying resolution in two distinct environments: circuit/packet switched telecommunications and PC Local Area Networks (LANs).

DESCRIPTION: There is a growing need to provide video and still imagery to both commanders and front-line troops on the battlefield. This is a thrust of Battlefield Information Systems -2015 (BIS-2015). In order to provide such imagery over limited bandwidth, new and improved lossless and lossy compression techniques for imagery need to be explored, developed and exploited. Further exploration on both intra-frame and inter-frame compression techniques for live video need to be examined. New techniques, such as wavelets and fractals need to be refined into usable software/hardware to meet the Army's needs.

Phase I: Survey existing video and imagery compression techniques with a key emphasis on maximum compression possible with limited loss. The approach and feasibility of a transcoding technique to standards such as National Imagery Transmission Format (NITF), Motion Picture Experts Group (MPEG), Joint Photographic Experts Group (JPEG), or P*64 from any state-of-the-art technique should also be clearly defined.

Phase II: Implement one or more of the recommended techniques from Phase I, including the transcoding device in prototype hardware/software to interface with existing or developing systems such as the Soldier's Computer, Mobile Subscriber Equipment, or SINCGARS radio. Demonstrate this working prototype with simple scenarios at Ft. Monmouth upon completion of the project. The prototype system, along with all hardware/software will become the property of the Government upon contract completion. Rights to pre-existing algorithms and software will remain with the originator, with the government retaining a user license for the prototype system.

Potential Commercial Market: The area of video compression, both for video teleconferencing, multimedia conferences, and PC distribution is rapidly expanding. This product has unlimited potential in the commercial world and can be utilized by any large telecommunications carrier or PC hardware/software house.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-188 TITLE: Spread Spectrum Technology for Communications on the Move

CATEGORY: Advanced Development

OBJECTIVE: The objective of the Phase I effort is to investigate the feasibility of developing a spread spectrum mobile radio communications system (including suitable antenna design) capable of transmitting and receiving digital voice, data, and video in a multi-user environment to support line-of-sight (LOS) and non-LOS communications on the move.

DESCRIPTION: The use of Spread Spectrum technology will allow radio communications on the move between multiple users at the same time. Considerations shall be given to minimizing multipath, mutual interference between users and spectrum allocation, while maximizing distance between users. Consideration shall also be given to efficient baseband modulation and error correction coding techniques to minimize emission bandwidth and Signal-to-Noise-Ratio (SNR) requirements for a given Bit-Error-Rate (BER). Maximum use of commercially available equipment shall be considered.

Phase I: Investigate the feasibility of developing a spread spectrum mobile radio communications system (including antenna design) capable of transmitting and receiving digital voice, data, and video in a multi-user environment to support line-of-sight (LOS) and non-LOS communications on the move.

Phase II: Phase II effort will continue ongoing research and development efforts of the Phase I program including hardware development.

Potential Commercial Market: Potential commercial market use of this technology is in multi-user wireless mobile communications.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-190 TITLE: Interoperable Power Adapter and Charger (IPAC) Technology

CATEGORY: Advanced Development

OBJECTIVE: Analyze, develop and evaluate advanced electric power conditioning and battery charger technology interoperable with U.S. Army manportable command, control, communications, computer, and intelligence (C4I) equipment; rechargeable energy storage devices; and commercial and military electric power sources.

DESCRIPTION: Electric power generation and storage is a principal operating and support (O&S) life cycle cost driver of sophisticated military equipment. Primary battery types are routinely assigned as principal electric power sources for U.S. Army manportable C4I equipment due to mission critical operational, performance, and environmental requirements. Equipment utilization and maintenance procedures and primary battery supply acquisition, storage, transportation and disposal practices significantly contribute to increased cost per unit energy and decreased energy capacity of primary battery types despite technical advancements in electrochemical primary cell chemistries and battery designs. A lightweight, manportable device is needed which is interoperable with a variety of commercial and military electric power sources (i.e., generator sets, vehicle power, auxiliary power units, etc.) U.S. Army manportable C4I equipment, and rechargeable energy storage devices in a tactical field environment. The IPAC device will implement advanced electric power conditioning components, microelectronic devices, and secondary battery charging techniques to provide quality electric power to manportable C4I equipment and to increase the efficiency and prolong the service life of secondary batteries. The IPAC design will provide an uninterrupted power supply capability for manportable C4I equipment, where required. The IPAC device will be reliable and survivable, and feature a modular design and user interface for easy operation and maintenance in hostile military environments.

Phase I: Conduct investigation, analyses, synthesis, and technical tests to identify and allocate functional requirements. Document initial research, preliminary design, and development plans for Phase II.

Phase II: Develop, test, and evaluate engineering development model to demonstrate feasibility of IPAC design. Update design and document Phase II effort and plans for commercialization.

Potential Commercial Market: The IPAC technology will support both military and commercial needs in the manportable C4I and telecommunications equipment marketplace.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-191 TITLE: Parallel Processing Effort

CATEGORY: Exploratory Development

OBJECTIVE: To survey and develop software support tools in the field of parallel processing.

DESCRIPTION: As imbedded processor applications become more and more complex the need for greater processor speed is becoming critical. The increases in throughput of single processors has not kept pace with the computational demands of the applications and functions. This situation is expected to worsen as fabrication and construction techniques reach their theoretical limits. The most attractive solution to the throughput shortfall is to employ multiple processors performing parallel computations. This solution creates another problem. How is a complex application divided into individual tasks in a manner which maximizes temporal independences?

Phase I: The contractor shall identify the functions necessary to support the government's requirements in the field of parallel processing. To satisfy those requirements the contractor shall survey the field of commercially-off-the-shelf (COTS) and developmental products which support parallel processing. Of interest to the government are software development products and operating systems which facilitate the development of parallel processing software, the supporting of existing single processor software to parallel processor platforms and the execution of parallel processing software. Issues such as processor throughput optimization through static and dynamic load balancing, degree of automation and availability are of particular

importance and should be highlighted in the survey. If the survey fails to identify parallel processing products which are sufficiently mature for practical employment, the contractor shall identify those agencies which are considered preeminent in the field of parallel processing research and provide recommendations to the government as to the best development course to follow, along with estimated costs. All recommendations must be amply supported by documented current work in the field of parallel processing. As Phase II will involve development on the part of the contractor to a minimum of one half the expenditure, contractor must document it's own qualifications to perform development work to generate the products required. The documentation must include past work in the field.

Phase II: The contractor shall initiate the Government approved development course and produce the required parallel processing products and capabilities identified as a result of Phase I.

Potential Commercial Market: This work could result in a very marketable product as the trend in the computer industry is tending toward multi-processor platforms but the software development tools are not keeping pace with the hardware.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-192 TITLE: Soldier Identification (SID)

CATEGORY: Exploratory Development

OBJECTIVE: Develop, test and demonstrate the capabilities to identify individual soldiers through the use of cooperative and/or non-cooperative techniques.

DESCRIPTION: The increasing use of weapons capable to engage targets at ranges beyond aided and unaided visual capabilities as well as the advent of the non linear battlefield has heightened the need for SID capabilities. This effort is aimed at developing and demonstrating one or more techniques to identify at least the allegiance of individual soldiers. As a reaction to fratricide issue from Operation Desert Storm this effort will emphasize the identification of friendly forces. Given that friendly individual soldiers are to be identified, it is expected for cooperative techniques to have the highest payoff. Cooperative techniques are those that require an interaction between the interrogator and the responder. This interaction: could be either automatic or manual were the interrogated soldier is alerted to initiate a response; could consist of an exchange of energy transmission at different wavelengths (e.g., RF, optical, acoustic) and; must provide for a small, lightweight manportable responder system. The system should also provide covert and secure operation. Covert operation reduces the probability of intercept (non-exploitable) and secure operation reduces the potential for compromises.

Phase I: Demonstrate the feasibility of the solution by analysis, simulation or laboratory testing. Feasibility will be established using specific measures of effectiveness to be defined during the kickoff meeting. Those measures will be based on specific Government requirements. If deficiencies are identified, alternatives will be proposed based on a trade off analysis.

Phase II: Design, develop, prototype and demonstrate the SID system as per the proposed configuration of Phase I. The demonstration will take into account operational issues to include but not limited to covert and secure operation, size and weight of the responder and host systems for the interrogator.

Potential Commercial Market: A derivative of the SID system could be used for civilian applications where detection and identification of items and personnel from 100 meters or so is required. Some of the envisioned applications include: inventory, motor vehicle identification and intelligent intrusion detection systems. Under the inventory application, part numbers of items could be quickly and automatically recorded without handling the items and even if the items are packaged for shipment and assembled into a system.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-193 TITLE: Millimeter Wave (MMW) Radar Measurement of Ice Formation on Aircraft Wings

CATEGORY: Exploratory Development

OBJECTIVE: Analyze the feasibility of using a radar to measure the amount of ice accumulated on an aircraft wing.

Phase I: Conduct an analysis of the applicability of MMW radar's capability to measure the formation of ice on aircraft wings and rotors. Investigate High Range Resolution requirements to map the aircraft wing. Define the radar parameters necessary to measure the boundary layers between ice, slush and the metal wing. Define the impact of atmospherics on the measurement of ice on the wings. Identify the performance range of a MMW radar in conducting the measurement in various levels of snow, sleet, or freezing rain.

Phase II: Utilizing the Radar Division's MMW radar target measurement system, collect and analyze data on ice measurement using radar. Provide a detailed report and system performance specification.

Potential Commercial Market: Airport de-icing efforts. Ice detection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-194 TITLE: Radar and Communications Intercept and Analysis System

CATEGORY: Exploratory Development

OBJECTIVE: To develop an RF Intercept System capable of analyzing, depicting and graphical representation of jamming techniques in simulated and actual environments during real time scenarios. The frequency band of interest is 500 MHZ through 40 GHZ and will be capable of pulse characterization.

DESCRIPTION: A need currently exists to develop a system or systems which allow both communication and radar jamming effectiveness to be evaluated during run time of a system. The ability to utilize this same equipment for live testing is desirable.

Phase I: During this phase, the offeror will analyze the specific requirements to IEWD and their applicability to the simulated and real environments being used in the Systems Integration/techniques development laboratory. As a result of this analysis, the offeror will generate a complete design and integration plan. The offeror is requested to examine commercially available systems and subsystems in order to minimize purchase, maintenance and operational costs. The offeror will delineate and provide hardware recommendations which will meet the spirit of the "objective" and "description" portions above. In addition, they will specify all hardware and highlight the attributes of all recommended hardware subsystems, systems and pieceparts. In addition, the preliminary innovation integration scheme(s) to be used in achieving this effort will be identified.

Phase II: The offeror will procure/fabricate/design the necessary hardware to meet the general requirements set forth here and the specific requirements as delineated by the contract Statement of Work (SOW). The offeror will integrate and test the delivered system(s) according to a test plan approved by the government. The offeror will train government personnel as necessary to enable self-sufficient operation of the equipment by government personnel.

Potential Commercial Market: Applications may include commercial Radar and Communications Analysis (Terrestrial/Space Comm and Commercial Radar analysis, FAA, NASA, etc.). Potential customers may include FAA, NASA, DEA, and FBI. This system may be a viable candidate for superconducting material usage/integration.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-195 TITLE: Radar Target Simulators

CATEGORY: Exploratory Development

OBJECTIVE: Develop design concepts for radar target simulators. Simulator would be applicable to radar cross section measurements in support of low observable technologies.

DESCRIPTION: Radar target simulators are needed which will provide small size units which will draw small amounts of prime power and simulate radar targets with varying velocity (Doppler frequencies), amplitude (radar cross section), and range (pulse delay). These simulators are meant for field use in calibrating radars, and will be designed to operate off 12 volt vehicle battery power. The radars operational frequencies will range from 1 to 95 GHz. Target velocities will range from 1 m/sec to 200 m/sec, radar cross section will be capable of being varied over a 50 db range, and range will be capable of being varied for 1km to 50km. The simulators would be designed to be observed from airborne as well as ground based radars. GENERAL: Radars, particularly instrumentation radars, are required to provide accurate target amplitude and positional information. When performing radar field calibration, it is often very expensive and time consuming to position varying cross section calibrated targets at a variety of ranges. Simulators would significantly reduce the measurement problem, as well as provide improvements when doing multipath measurements.

Phase I: Create the design for the radar target simulators over the requirements stated above.

Phase II: Develop and fabricate models for selected frequencies for demonstration and test.

Potential Commercial Market: This SBIR would have commercial application in the Federal Aviation Agency Research & Development for commercial aircraft radar design.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-196 TITLE: Advanced Deception Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop advanced Deception Capabilities to complement existing technologies and systems.

DESCRIPTION: Low intensity conflict being more of a probability places convert and low observable technologies/techniques in the fore front.

Phase I: To devise, develop and plan a program to initiate Advanced Deception Techniques, complementing those currently available. These techniques/devices will utilize state of the art electronics and will provide cost effectiveness to the government. The offeror will provide Rough Order of Magnitude (ROMs) for those techniques of which hardware will be built.

Phase II: Hardware development and test laboratory and field test against surrogate threats.

Potential Commercial Market: Although this topic may not be directly applicable to one commercial market, the inherent technology required will enhance state of the art in several areas: packaging, electronic density, precision delay devices, RF power.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-197 TITLE: Synthetic Aperture Radar (SAR) Countermeasure (CM)

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-199 TITLE: Large Well Capacity Input Circuit

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate a Readout Integrated Circuit (ROIC) Input Circuit having well capacity = 1.0E8 carriers/400 um^2

DESCRIPTION: Mercury Cadmium Telluride (HCT) has a high quantum efficiency that cannot presently be taken advantage of in STARING applications. This is due to the limited well capacity of the integrating capacitor in the ROIC input circuit. The impact is that the 30 frame per second HCT staring Focal Plane Arrays (FPAs) have sensitivity little better than Platinum Silicide (PtSi) Staring FPAs. Input circuits with well capacities an order of magnitude grater than PtSi in similar sized unit cells would provide significant sensitivity margin over PtSi that could be traded for smaller optics, etc. The technology used here would also permit capacitors with small physical size in SCANNING unit cells and leave room for other functions.

Phase I: During this phase of the program a study/investigation will be made to determine material, processing techniques and capacitor architectures that could lead to an increase in the capacitor's well capacity. Other storage circuits which could possibly replace the capacitor will also be investigated. Concepts to be implemented in Phase II will be identified.

Phase II: During this phase of the program, concepts identified in Phase I will be implemented. The effort would be performed using small, inexpensive test devices and SPICE modeling. The well capacity of each test device will be measured. Failures as well as successes will be explained. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICs/FPAs which require large well capacity.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-200 TITLE: Superlinear Readout Integrated Circuit (ROIC)

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate a ROIC having linearity sufficient to achieve Standardized Advanced Dewar Assembly I (SADA I) and Standardized Advanced Dewar Assembly II (SADA II) post correction uniformity.

DESCRIPTION: A ROIC with sufficient linearity to achieve the 2-point post correction uniformity required by SADA I AND SADA II has not been developed. Present silicon models are insufficient to directly design to the required level of approximately .02% non-linearity.

Phase I: During this phase of the program, a ROIC circuit between the detector input node and the ROIC output driver would be designed with .02 nonlinearity. The effort would be performed using small, inexpensive test devices and SPICE modeling. A number of iterations would be conducted until the proper circuit design was defined.

Phase II: During Phase II, the final circuit design of Phase I would be fabricated and tested for linearity, dynamic range, noise, gain, and frequency response. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane Array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICs/FPAs which require approximately .02% nonlinearity.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-201 TITLE: Zero Droop Readout Integrated Circuit (ROIC) Thermal Reference Substraction (TRS)

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate an On-Readout Integrated Circuit (ROIC) Thermal Reference Analog Memory Element with Drift/Droop Rate Slower Than .01% of Full Signal Per Hour.

DESCRIPTION: The present Standardized Advanced Dewar Assembly (SADA) pre-correction offset fixed pattern noise is 250 mv p-p. This uses some of the system A/D dynamic range, but, more importantly, increases residual (uncorrectable) A/D convertor fixed pattern noise and hence scene fixed pattern noise. Focal Plane Array (FPA) Thermal Reference Substraction (TRS) circuitry that reduced the pre-correction offset fixed pattern noise by about 2 orders of magnitude has been implemented, however, system users do not desire to use it because of possible droop and the fact that the set level changes from frame to frame too fast for system gain and offset correction to fix.

Phase I: During this phase of the program, an on-ROIC TRS circuit with infinite droop time ("infinite hold subtraction circuit") will be designed. The design will be such that the offset level could be set once at system turn-on and not further changed. The effort would be performed using small, inexpensive test devices and SPICE modeling. A number of iterations would be conducted until the proper circuit design was defined.

Phase II: During Phase II, the final circuit design of Phase I would be fabricated and tested for offset correction and droop time. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane Array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICS/FPAs that require offset fixed pattern noise correction.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-202 TITLE: Technology for Transition from Ada 83 to Ada 9X

CATEGORY: Exploratory Development

OBJECTIVE: Determine approaches, techniques, and appropriate support tools that will facilitate the transition to Ada 9X on mission-critical software systems currently written in Ada 83.

DESCRIPTION: The Ada language revision, Ada 9X, will result in increased capabilities for Army mission-critical systems previously developed in Ada 83. These will include, for example, facilities for real-time programming such as data synchronization with protected types, support for programming-in-the-large through hierarchical library units, and support for object-oriented programming concepts. There will be advantages to transitioning software to Ada 9X with its increased capabilities if it can be done in an automated way that doesn't jeopardize the robustness and integrity of the original system. This SBIR will address the issues associated with providing effective methods and processes for transitioning Ada 83 mission-critical software to Ada 9X. This may include but not be limited to: redesign aids, translation techniques, reengineering approaches, inclusion of performance considerations, and testing. Having effective transition approaches to use Ada 9X, a standard language built on software engineering principles, will aid in lowering software maintenance and support costs.

Phase I: Formulate an approach and appropriate support to expedite the transition of Ada 83 mission-critical software systems to Ada 9X.

Phase II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I.

Potential Commercial Market: More commercial applications are using Ada for their large software projects. Having effective ways to transition to Ada 9X will allow them to incorporate the advantages and features of Ada 9X and ensure a greater market for Ada in the future.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-203 TITLE: Management Metrics Decision System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a management metrics decision system to assist in making programmatic and technical decisions concerning management metrics program implementations on software projects.

DESCRIPTION: There is critical need to furnish high-level insight of software lifecycle management and technical processes and products, in order to give managers control over project direction. Insight comes from smart use of software management metrics. Managers need assistance in making decisions concerning; whether or not metrics will be helpful; what measures; and what resources, are required; what corrective actions are available and reasonable to apply; and, which corrective actions represent acceptable risk. The decision system should include an informational subsystem, to answer questions on metrics program implementations, that is based on input provided to a menu-driven query subsystem which addresses system technical approach and programmatic priorities. This subsystem will help a manager decide on a metrics program and its specifics, and provide information on the most useful measures. The decision system will also be used for sensitivity studies, to do trade-off analyses of resource requirements. For on-going metrics programs, it would help decide alternative courses of corrective action based on metric reports and correlations. Flexibility is needed to accommodate existing metric sets, and how each addresses primary manager concerns. Use of management metrics is now widely accepted as an effective means of providing managers control of their projects based on their priorities, risks and constraints. Metrics support the concept of "building quality in", and thus will lead to significant cost savings in the area of maintenance and support of deployed systems. The proposed management metrics decision system will be a major contributor to building quality systems and reducing operational support costs.

Phase I: Demonstrate proof-of-concept and feasibility. Develop a plan of approach. Address risk and technical alternatives.

Phase II: Develop prototype of the system and provide a demonstration of its capabilities. Develop technology transfer mechanisms such as informal seminars and, hands-on tutoring including management games scenarios.

Potential Commercial Market: This type of automated technology is of prime interest to acquisition organizations charged with the development of large, complex defense industry software systems, and therefore, is of prime interest to private sector defense contractors.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-204 TITLE: Ada 9X Graphical Design Support

CATEGORY: Exploratory Development

OBJECTIVE: Determine methods and appropriate automated graphical support that will facilitate the design of mission-critical software applications, in particular real-time, using Ada 9X as the implementation language.

DESCRIPTION: The Ada language revision, Ada 9X, will result in increased capabilities for the development of Army mission-critical systems. These will include, for example, facilities for real-time programming such as data synchronization with protected types, support for programming-in-the-large, and support for object-oriented programming concepts. Methods that currently exist for supporting the design of software using Ada 83 will have to be extended and adapted to incorporate all of the features proposed for Ada 9X. To enhance the communication required between management and the design team, and to increase productivity, the methods must allow the visualization of the design, and have automated support. Having effective approaches for developing mission critical applications using Ada 9X, a standard language built on software engineering principles, will aid in lowering software maintenance and support costs. This SBIR will address the issues associated with providing graphical support for the design of Ada 9X mission-critical software. This may include but not be limited to: the selection of a method that uses graphical representations that correspond to the entire proposed Ada 9X language revision and an approach for addressing application performance considerations.

Phase I: Select a method and define graphical support needed for the creation of mission-critical software systems using Ada 9X. All features in the 9X version of the language must be addressed.

Phase II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I.

Potential Commercial Market: The number of commercial companies using Ada for their large software projects is increasing. Using an effective graphical design method that incorporates the advantages and features of Ada 9X and has automated support, will allow them to use Ada for a wider range of applications, ensuring a greater market for Ada in the future.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-205 TITLE: Intelligent Multi-Mode Tactical Communications Interface

CATEGORY: Engineering Development

OBJECTIVE: To develop an intelligent communications processor interface for continuous assessment and selection of the best available communications ports.

DESCRIPTION: Army tactical communications systems currently have multiple medias available for the transport of data communications. The focus for this effort is to develop a user friendly solution that will allow simultaneous connectivity to all available communications media with continuous fully automated assessment and selection of the best mode to be used at any given time. Developed product ideally would be modular for inclusion in standard data terminals and not unnecessarily degrade other operations and functions.

Phase I: Define parameters and algorithms for software design and determine preliminary hardware approach.

Phase II: Develop and refine technical requirements and build functional prototype, demonstrate product in the Army CECOM Comm Design Center with MSE.

Potential Commercial Market: Tailoring of specific interfaces on both the terminal and communications media interfaces of the device would enable wide applications in commercial as well as both strategic and tactical military applications.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-206 TITLE: Solar Power Array/Satellite Communications Antenna

CATEGORY: Exploratory Development

OBJECTIVE: To combine a solar power array with a satellite communications antenna.

DESCRIPTION: Satellite communication is a necessity for teams that are deployed away from their parent organizations. Such teams must be self-sufficient and cannot rely on resupply of batteries. A solar power system capable of operating the radios during the day and recharging batteries for night operations will increase the teams self-sufficiency and reduce operating costs Combining the system with the radio's antenna eliminates the need to carry a separate antenna. The combined antenna and solar power array must fold to a small size and be lightweight. The antenna must be compatible with commercial and military Ultra High Frequency (UHF) radios currently used by the U.S. Military.

Phase I: This phase of the program will survey current UHF satellite communications systems and radios, government agencies and potential commercial users for requirements, conduct trade off studies and develop a preliminary design for the array/antenna. The deliverables from this phase shall include a functional specification for the array/antenna, design report and survey and trade off study results.

Phase II: Complete the design, fabricate and demonstrate fully capable solar power array/antennas. The contractor shall explore the adaptation of the array/antenna technology to other frequencies and systems. The deliverables from this phase shall include four array/antennas, commercial design drawings, a technical report on the performance of the array/antennas and report on the adaptation of the array/antenna to other frequencies/systems.

Potential Commercial Market: A combined antenna and solar power array may be used with commercial satellite communication systems and adapting it to other frequencies and radio systems. The solar power array/antenna may be used to power unattended radio systems used for weather stations geological surveys, etc.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-207 TITLE: Versa Module Euro Standard (VMEbus) (ANSI/IEEE-1014-1987) Compliant Radio Frequency (RF) Down Convertor

CATEGORY: Advanced Development

OBJECTIVE: To construct a high performance VMEbus compliance RF down convertor operational over a frequency range of DC to 1.8 Ghz.

DESCRIPTION: VMEbus signal processing systems are supporting a growing emphasis on common module architectures. A VMEbus RF down convertor is a natural compliment to the wide range of high performance signal processing boards available for the VMEbus. An excellent selection of Microwave Monolithic Integrated Circuit (MMIC) devices, a simple Intermediate Frequency (IF) plan and well understood noise mitigation practices allows this design to be developed with only a moderate amount of risk. The IF strip will contain a sub-octave preselector, digital attenuator and two signal paths: direct current (DC) to 10 Mhz to 1800 Mhz. The DC to 10 Mhz path will be preselected, amplified and directly digitized using a 25.6 Mhz sampling analog to digital convertor (ADC). The 10-1800 Mhz path will be upconverted to a first IF of approximately 3700 Mhz. The second local oscillator (LO) will down convert to a common IF of 70 Mhz, and the third LO will baseband to RF to a 6.4 Mhz center frequency with a 10 Mhz wide bandwidth. This module is expected to utilize one 6U VMEbus slot. The 10 Mhz analog baseband output will be supplied through the front panel. Commercially available components will be used throughout. The local oscillators will be supplied by a second VMEbus card. Target performance will be tuning speeds of less than 100 usec with very low close-in and wideband phase noise. This module is expected to utilize one 6U VMEbus slot. Phase coherence among LOs would make the down convertor suitable for direction finding. Local oscillators will be supplied through front panel connectors. All control functions will be programmed via VMEbus. Full Institute of Electrical and Electronic Engineers (IEEE) P.1014 compatibility will be required. Proper attention to design details will ensure the VMEbus noise problems are successfully minimized.

Phase I: The contractor will investigate the IF plan and choose the RF components (connectors antenuators, switches, mixers, amplifiers and filters) to implement the design. Careful attention will be given to noise abatement and RF shielding. The LO module will also be designed. The IF strip will be simulated using spur and noise figure analysis. A final report with schematics, parts lists, and simulation results will detail the Phase I effort.

Phase II: The contractor will construct the down convertor designed during Phase I. This will include layout, parts procurement, test and debug. Deliverables will include working convertor, all design information for convertor construction and all modeling and simulation results.

Potential Commercial Market: There is a large market within the intelligence community for small, standardized signal processing modules. This RF module would benefit the Army's Ground Based CommonSensor, Guardrail, Trojan and other signal intercept programs. In addition this design would immediately become part of a companies standard product line. By developing a high performance RF downconvertor for the VMEbus, signal processing applications throughout DoD have a vehicle for total integration of a standard, commercially available architecture.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-209 TITLE: Frequency Scan Optimization

CATEGORY: Basic Research

OBJECTIVE: Schedule a list of prioritized channels to maximize the numbers of high-interest signals detected per scan.

DESCRIPTION: Given a list of labeled frequency bands, a table which prioritized each band, the duration of a signal expected to appear in a band, and a table which indicates over what broad time interval a signal is normally active, develop a schedule to search the spectrum which maximizes the number of signals of high interest detected during any particular scan. The schedule consists of an ordered list of pairs, where each pair is a frequency band with an associated dwell time. Accommodations should be made to add new bands or delete old bands at arbitrary times. This problem is classic, but remains unsolved and very relevant. Army applications including scheduling scans for the TROJAN system. Potential offerors should be advised that the problem cannot be addressed simply as an exercise in expected value as defined in classical probability theory, since the scheduling problem is NP-hard, in the same class as the knapsack problem, bin packing, and the traveling salesman problem. Approximate solutions are acceptable, but unless accompanied by convincing proofs that estimates converge within a neighborhood of admissibility, will be greeted with skepticism.

Phase I: Development of scheduling technique and accompanying proof of convergence within bounds of admissible result. Limited implementation with ten sets of signal data generated by the offeror, each containing one hundred simulated signals of varying frequency, duration, bandwidth, priority and daily temporal mode.

Phase II: Upon government acceptance of Phase I results, offeror may proceed with full-scale implementation on a library of signals, generated by the offeror and accepted by the government as representative.

Potential Commercial Market: Communications industry, cellular and cordless phones, citizens band radio, surveillance, counternarcotics, rescue, electronic countermeasures.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-210 TITLE: Advanced Hardware for Intelligence Electronic Warfare (IEW0) Common Architectures

CATEGORY: Exploratory Development

OBJECTIVE: Reduction of Operations and Support (O&S) Costs through the use of common digital hardware throughout an IEW System.

DESCRIPTION: Current Communications ESM/ECM systems are essentially totally digital hardware. However the systems are composed of multiple types of different digital technology: specialized signal processors; general purpose computers; fast personal computers; signal analysis workstations; and application specific integrated circuits. These components (as line replaceable items or circuit card assemblies) must be stocked as spares and configuration managed separately. Operational and Support (O&S) costs are driven by the numbers of different items that must be maintained in the inventory. The highly parallel architecture as now used allows consideration of a system composed of common digital processing components for almost all functions. Although the common digital processor may be more expensive than any one component now used, the large number, even in low density equipment field applications, of the same component can reduce production costs and O&S costs. The common processor must account for the high data processing speeds needed for high dynamic range, 4k to 16k point Fast Fourier Transforms (FFT), signal acquisition/analysis in milliseconds in dense environments and real time multiple signal ECM response. This may be accomplished with common processors through the use of innovative algorithms, special application chips host common, lower performance, processors or a combination of approaches.

Phase I: This will be trade-offs of various candidate architectures, simulations of the response of these architectures for performance and estimates of resulting O&S cost reductions to be achieved. Key issues are ways to handle both low and high speed functions, input and output translations, data bus and signal path optimization and producibility/costs per processor/function. Driving point functions and their sensitivity must be identified. A final technical report will describe in detail the results.

Phase II: A single real time operating breadboard thread of the selected architecture and components will be assembled to verify performance and better refine O&S cost reduction estimates. The deliverables would be the architectural design of a system based on the breadboard and a final technical report.

Potential Commercial Market: In this phase it is anticipated a sponsor would fund an advanced technology test bed demonstration of a complete ESM/ECM system. In addition this concept has application to radio transceivers of all types, including satellite communications and radio data handling networks.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-211 TITLE: Data Communications Support for C4I for the Warrior

CATEGORY: Engineering Development

OBJECTIVE: To develop software and/or hardware products to enable commercial personal computer networking on existing Army tactical data systems.

DESCRIPTION: Current Army concepts call for a seamless C3 architecture linking tactical and strategic data communications resources. Computer assets provide the remaining element for the total C4I concept. Modifications to existing commercial networking products (supporting Dod protocols) will result in global C4I capabilities via existing Army tactical and strategic networks. The current approach is to develop or enhance commercial networking software and hardware technologies compatible with the Army tactical interface specifications (based on DoD protocols) for standard commercial automation platforms (personal computers).

Phase I: This is the concept validation phase. Alternative products and approaches should be investigated. The only required deliverable in Phase I is a report documenting the results of the investigations and analyses and describing the selected candidate products.

Phase II: This is the prototyping phase. A prototype of the proposed product will be developed and demonstrated to ensure interoperability with tactical systems at CECOM.

Potential Commercial Market: Lack of products that provide this functionality is a current void in computer communications products. Data networks targeted to support these technologies exist and are stable. Computer communications products for the strategic echelons exist to provide the base for the enhancements outlined in this effort.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-260 TITLE: Wavelet Characterization of Clutter for Enhanced Detection and Identification of Low Flying Target

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the possibility of characterizing various clutter environments for infrared (IR) or radio frequency (RF) sensors or both in real time and produce appropriate matched filters or signal processing algorithms for detection and/or identification of low flying targets.

DESCRIPTION: The U.S. Army Missile Command has been pursuing technology base programs on sensors for future Air Defense applications. The type of weapon system envisioned is a remotely launched missile which is guided through midcourse inertially with periodic updates from a fire control sensor. In the terminal mode the missile will be diving toward an estimated collision point while trying to acquire the target in an unknown clutter background. To enhance detection and identification, the clutter environment might be characterized using wavelet transforms. The resulting wavelet transform coefficients could then be used in real time algorithms to define the present clutter and use that information to detect and/or identify low flying targets. This technique might be utilized in the missile seeker for detection or in the ground based fire control sensor for both detection and identification purposes.

Phase I: The contractor shall investigate the use of wavelets or wavelet packets specifically designed to characterize clutter environments for either RF or IR sensors or both. This investigation may involve only the missile seeker case or the ground based sensor case or both. The use of actual clutter data is highly desirable in this part of the task. The goal is to demonstrate the capability (given appropriate computational resources) to characterize any one of several types of clutter environment in real time and to outline the approach which will be used to perform detection and/or identification.

Phase II: The contractor shall utilize the wavelet transform technique determined in Phase I as a starting point. The goal of this phase of the task is to demonstrate an algorithm which may operate in real time to produce either a matched filter or suitable signal processing for detection or identification of low flying targets in clutter. The contractor shall demonstrate the technique in real time using an appropriate test bed and real targets.

Potential Commercial Market: The results of this research is applicable to air traffic control, medical screening, security and surveillance, robotics and especially to earth sciences and mine detection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-269 TITLE: Transmitter-Receiver Isolation for Continuous Wave (CW) Radar Antenna

CATEGORY: Exploratory Development

OBJECTIVE: To develop a means of isolation between the transmit and receive antennas of a CW (continuous wave) radar that provides 110 dB or greater isolation for vertically polarized radiation.

DESCRIPTION: In order to achieve maximum detection range, sufficient isolation between the transmit and receive antennas of CW radars must be achieved. Septum designs provide one alternative to achieve an isolation level of no less than 110 dB for vertically polarized, stacked antennas with a one foot separation are sought. The designs should perform over the C, X, and Ku frequency bands to maximize their potential applications for various types of radars and missile seekers

Phase I: Provide detailed analysis of potential septum designs.

Phase II: Fabricate, test, and iterate designs of most promising septums.

Potential Commercial Market: This technology has commercial market potential for industrial use in telecommunications and for government use in radar systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-272 TITLE: Real Time Lossless Data Compression Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop real time, lossless or near lossless, data compression techniques for high data rate sensors such as EO, IIR, MMW seekers, and fiber optic guidance system.

DESCRIPTION: Many presently fielded weapon systems as well as systems on the drawing boards, must transmit and store large volumes of digital data generated by EO (electro-optical), IIR (imaging infrared), and MMW (millimeter wave) sensors. The storage devices and data link equipment is large and cumbersome due to the volume of data that must be processed. Real time data compression offers the advantage of smaller storage devices and data link systems by reducing the volume of data without reducing the amount of information contained in the data. Innovative ideas are sought for the design and implementation of real time lossless or near lossless (less than 10 to the -3 BER) data compression techniques. The design should include techniques that operate at real time speeds (real time in this case, is that the compression technique works quickly enough that no noticeable time delay occurs if the sensor data is being viewed by an operator on a monitor while providing for a maximum retention of information in a minimum of compressed data. Proposals should contain detailed description of the technique as well as a description of its implementation. Emphasis will be placed on the techniques which are lossless or near lossless (less than 10 to -3 BER), and have the best information to compressed data ratios for digital data from EO, IIR, and MMW sensors.

Phase I: Provide detailed analysis of the proposed design including experimental evaluation plan.

Phase II: Develop hardware and perform laboratory demonstrations to verify the technical approach.

Potential Commercial Market: Millimeter wave electromagnetic energy penetrates some of the severest atmospheric conditions known and still provides a sufficient signal margin to produce images. Commercial markets can benefit from the use of this technology in several areas, however, one of the most important would be landing commercial aircraft in dense fog. The ability to image the runway would allow the pilot to safely land the aircraft. The difficulty arises in the storage of the data required to accomplish the image processing task. Real time data compression offers a solution to this storage problem.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-273 TITLE: Millimeter Wave Conformal Antenna

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-274 TITLE: Wide Bandwidth End-Fire Slotline Ring Antenna

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-278 TITLE: Low Noise Frequency Agile Exciter

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-300 TITLE: Visible Sensors

CATEGORY: Basic Research

OBJECTIVE: Innovative approaches and designs to improve visible sensor performance for ASAT application.

DESCRIPTION: This program is intended to promote advances in visible sensor design and related technologies for Kinetic Energy Anti-Satellite Program application. A sensor and its associated systems will provide to the kill vehicle the means to update position by stellar alignment as well as to detect, acquire, and track target satellites against a variety of backgrounds. The current ASAT design employs a staring visible seeker. Technical challenges include off-axis light rejection, platform stability (jitter tolerance), long term storage reliability, cooling requirements. New and innovative approaches to these requirements using advanced concepts are sought. In addition to novel sensing concepts, sensor-related device technology is also needed in areas such as advanced focal plane arrays, improved device efficiency, improved optic baffle designs, platform damping, and image intensification methods.

Phase I: A phase I effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: A phase II effort will include detailed design, fabrication, and evaluation of a working, but not necessarily optimized, breadboard or brassboard model. Phase II proposals will also include an assessment of commercial markets for the devices to be developed during this phase of the project.

Potential Commercial Market: New or improved visible sensor designs will be readily applicable to commercial use in areas such as video cameras, robotics vision, visible navigational aids, product inspection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-301 TITLE: Anti-Satellite Kinetic Energy Weapons

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-302 TITLE: Use of Tactical Lasers in Mine Detection and Counter-Mine Operations

CATEGORY: Advanced Development

OBJECTIVE: The objective of this development is to (1) explore possible methodologies using advanced tactical laser or laser concepts to remotely sense tactical minefields or other threat weapons and weapons systems on the battlefield, and (2) explore the potential capabilities of tactical lasers to neutralize and/or eliminate the detected minefields and weapon systems.

DESCRIPTION: Recent developments in laser technology have provided the potential to field relatively powerful tactical laser systems. Traditionally, lasers have been looked at as possible battlefield sensors, as well as, weapons to blind threat sensors and possibly destroy "soft" targets. This project would research specific methodologies that could possibly be employed to use lasers as remote sensors to locate and possibly destroy or neutralize tactical minefields.

Phase I: Research possible methodologies/techniques using lasers and laser technology to remotely sense tactical minefields. Research possible methodologies/mechanisms by which lasers can either destroy or neutralize tactical mines. Conduct preliminary design of laboratory and field experiments, using lasers available at HELSTF, to verify/validate research results.

Phase II: Refine the design of possible laboratory and field experiments to be conducted at HELSTF. Assist in the conduct of these experiments. Develop conceptual laser systems using methodologies validated by the research and experimental process.

Potential Commercial Market: Phase II proposals should also include a commercial applications for using laser technology for remote sensing.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-305 TITLE: Hydroacoustic Impact Location System for the East Reef Area of the Kwajalein Atoll (KA)

CATEGORY: Basic Research

OBJECTIVE: The objective of this topic is to determine if there are practical alternatives to air-dropped sonobuoys/deep-ocean transponders for detecting reentry vehicle (RV) impact locations in the East Reef Area of the KA using hydroacoustic sensors.

DESCRIPTION: There is a current need for a highly reliable, low cost sensor system to score RV impacts in the ocean area in proximity to the East Reef of the KA. The use of P3/Orion-deployed sonobuoys is expensive. Alternative hydroacoustic methods should be examined. Possibilities which might be considered include bottom mounted hydrophones and sonobuoys with GPS translators which are either bottom-moored, ship-deployed, or deployed by small planes. The area of interest extends to about 25 kilometers off the reef and reaches depths of about 3500 meters.

Phase I: Generation and analysis of alternatives. Selection of one option.

Phase II: Design of sensor system.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for use of hydroacoustic sensors in harbors and shipping lanes.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-307 TITLE: Prediction of Rocket Exhaust Plume Microwave Attenuation for Kwajalein Atoll (KA) Launches

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-310 TITLE: Automated Reduction of Kwajalein Missile Range (KMR) Optical Metric Data

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-311 TITLE: Economic Value of Weather Support for Range Operations

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-312 TITLE: Optical Sight Line Characterization

CATEGORY: Exploratory Development

OBJECTIVE: Optical measurements play a much greater role in range support, especially in strategic defense systems tests. Atmospheric effects can significantly degrade the fidelity of optical sensors. The goal of this research is to identify the best and most efficient way to characterize the atmosphere to remove these atmospheric effects from optical data.

DESCRIPTION: This program will focus on developments in passive or active technologies, systems and sub-systems which may be utilized in ground based and airborne applications. LIDARS and radars are the principal technologies of interest.

Phase I: Provide determination of feasibility by means of research, preliminary design, simulations and/or laboratory experimentation.

Phase II: Build upon the feasibility of Phase I results to provide demonstration through design, fabrication, and testing of a breadboard/brassboard model.

Phase III: Hardware will be developed specific to the ground based site or airborne application.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for methods of removing atmospheric effects from optical data.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-313 TITLE: The Use of Infrared Technology for Tracking and Scoring.

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-314 TITLE: Use of Satellite-Based Radiometry in CLEARSKY for Support of Range Operations

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-315 TITLE: Advanced Audio Cue Generation and Projection for Distributed Interactive Simulation (DIS) Platforms

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative audio special effects generation system capable of producing realistic 3-dimensional "battlefield" sound cues for DIS platforms.

DESCRIPTION: DIS synthetic battlespace environments such as the Army's Battlefield Distributed Simulation-Developmental(BDS-D) and Close Combat Tactical Trainer (CCTT) stand to benefit greatly from the creation of an advanced audio cue generation and projection system. Such a system should be capable of generating and projecting realistic complex representations of "battlefield" sound cues which include the Doppler effects of projectiles and other sound producing battlefield objects. These synthetically generated and projected "battle" sounds and cues should be perceived by the DIS training participants with the correct apparent sound intensity (within the published safety limitations) and spatial orientation.

Phase I: Develop cost effective DIS compatible concepts/designs for an advanced audio cue generation system.

Phase II: Implement the best approach from Phase I with the objective of demonstrating the feasibility and effectiveness.

Potential Commercial Market: Entertainment to include networked virtual environments and video arcades.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-316 TITLE: Force/Tactile Feedback for Virtual Reality Environments

CATEGORY: Exploratory Development

OBJECTIVE: To develop realistic force/tactile feedback for Virtual Reality(VR) power gloves such that "the grasping and touching" of virtual objects will result in realistic tactile cues.

DESCRIPTION: In a virtual cockpit environment the pilot may be required to interact with virtual controls such as the control stick and other control instrumentation. To make these interactions realistic the pilot should experience appropriate tactile cues through the hands and fingers. This capability might be achieved through the design and integration of force/tactile feedback technology into the VR power gloves.

Phase I: Explore alternative concepts and develop a design and cost estimate for integrating force/tactile feedback into VR power gloves.

Phase II: Implement the best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

Potential Commercial Market: Home video games and arcade games.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-326 TITLE: Preview Sensor Development

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a preview sensor for application in preview active suspension systems for combat vehicles.

DESCRIPTION: A sensor system that is capable of sensing cross-country terrain obstacles at a range of 5 - 30 feet in front of a combat vehicle is being solicited. The signal would be incorporated into an active suspension controller and provide feedback required to adjust suspension characteristics, braking or steering maneuvers. The sensor shall be able to distinguish solid obstacles (i.e., a rock versus a bush). The sensor shall be capable of sensing when an obstacle height is greater than the wheel travel of the vehicle. The sensor signature shall not be easily detected.

Phase I: The contractor will research promising sensor technologies and develop a concept for use in active suspension control. The design concept shall be proven from a feasibility standpoint. A final report will detail the Phase I effort.

Phase II: The contractor will continue to research, plan, and develop a computer controlled breadboard prototype of the sensing system. Laboratory bench testing shall be accomplished to prove the functionality of this concept. Concept shall be demonstrated on a combat vehicle based on further direction from TACOM engineers. The deliverables from this phase will include design drawings, software, technical report, and prototype system.

Potential Commercial Market: The preview sensing technology could benefit the automotive industry as well as the off-road vehicle market. Interest in the research years, both in the automotive industry and the military. Active suspension systems offer improved ride and handling, while increasing vehicle stability and safety.

OSCR: Previewing upcoming obstacles will allow the suspension to adapt to the terrain and reduce shock loadings to vehicle components both externally and internally. Reduced shock loadings correlates into improved reliability which leads to reduced O&S costs.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-334 TITLE: Battlefield Acoustics Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop a model that can simulate on acoustic battlefield environment. The model can be applied to airports, highways, and other complex environments.

DESCRIPTION: The project extends the single source vs. single receiver atmospheric acoustics problem to one where at least six sources can be tracked by a sensor system. At least four of the sources should be moving in user selected routes that can vary fro distances from 100 to 5,000 meters from the receiver. The receiver can be a simple or multi-faceted array. The model will vary environmental parameters such as atmosphere, terrain, wind direction, background noise and be able to predict probability of detection contour values based on baseline source-target configurations.

Phase I: Determine the feasibility of extending any of the existing government owned atmospheric models to realistic battlefield environments. This will involve enlarging targets to up to six sources where vehicle movement can be varied by the model user. Targets will be heavy, medium, light ground combat vehicles, wheeled vehicles, and auxiliary power units. Targets can be extended to those encousted near airports and industrial highways.

Phase II: Develop the model further by improving the analysis tools and internal databases required to perform the simulation. The model will be written in the Unix operating system using the C language. The model will be validated by a government test and provided to the government at the end of Phase II.

Potential Commercial Market: Commercial companies interested in complex noise surveillance located at airports and highways.

OPERATING & SUPPORT COSTS: The army is spending substantial funds to lower the acoustic self noise signature of ground combat vehicles. This model will analyze these low signature vehicles and apply the results to realistic battlefield acoustic conditions. Commercial companies are also interested i complex noise source environments. THis model would serve as a basis for coordination between government and private industry.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-344 TITLE: Rapid Measurement of Artillery Tube Elevation and Azimuth

CATEGORY: Engineering Development

OBJECTIVE: Development of a method/system capable of measuring Tube Elevation and Azimuth without interference with the ability to rapidly change Elevation and Azimuth. System needs to make precision measurements within a small fraction of a second. System measurements should be reasonably independent of the Artillery System internal measurement systems.

DESCRIPTION: The Advanced Field Artillery System (AFAS) will be capable of rapid emplacement, rapid fire, and of adjusting firing angles from round to round. AFAS will be semi-autonomous once a fire mission is started. A system external to AFAS is needed to verify the QE/Azimuth angles. To reduce/eliminate interference with test, the system must perform measurements as AFAS fires a round. Although it may be possible to perform some of this measurement by external measurement of internal artillery systems such as encoder angles, the preferred system would be independent of internal systems.

Phase I: Conceptual design of the measurement system, to include mathematical analysis of the probable accuracies of implementations of the concept. Also requires preliminary technical analysis of the ability to maintain accuracy under the shock and temperatures involved during firing. Some laboratory "proof of principle" demonstrations of critical components may be necessary where new technology is involved.

Phase II: Design, fabrication and test of field-capable prototypes enabling field demonstrations of the QE/Azimuth measurement system.

Potential Commercial Market: New, precision measurement technology would offer wide opportunity for all types of measurement applications, especially where non-interference in high shock environments is required.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-346 TITLE: Vehicle Position Location System

CATEGORY: Engineering Development

OBJECTIVE: Develop a prototype vehicle position location system for evaluation of system accuracy, reliability and operational ease.

DESCRIPTION: A vehicle position location system is required in support of a variety of tests including vehicular mobility and stability, tank turret stabilization system performance, and amphibious performance. The system must be able to track military vehicles on test courses moving at speeds up to 100 kmph at ranges of 30 to 1500 meters. The system must output three dimensional vehicle position location data in real-time at an update rate of 20 Hz with an accuracy of +/-0.01%. It is envisioned that the system will utilize optical and/or radio-frequency (RF) components; however, these components must not pose a safety hazard to either personnel or environment in the vicinity of the system. (Additional detail available at DTIC)

Phase I: Conduct a feasibility study to determine what type of components will most likely be utilized in the position location system (optical, RF, etc.). Provide design concept and technical information to support the concept.

Phase II: Initiate prototyping of a vehicle position location system for evaluation of system accuracy, reliability and operational ease.

Potential Commercial Market: Desired technology would produce significant upgrade in vehicle test capabilities utilized by both government and commercial vehicle developers.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-350 TITLE: Applications of Radar Imaging to High-Altitude Measurements

CATEGORY: Exploratory Development

OBJECTIVE: Adapt radar imaging technology to test center measurement requirements such as attitude of missiles and aircraft, miss distance between interceptor and target, detection of deployed objects, and determination of extent of damage to targets, all at high altitudes or long ranges.

DESCRIPTION: The U.S. Army White Sands Missile Range has developed measurement and processing techniques for extracting more and better information from coherent radar signals. Improved measurements include trajectory parameters, motion about the center of mass (e.g. spin and coning) and characteristics of events (e.g. time of occurrence and duration). Recent advances in radar imaging suggest it is now possible to adapt imaging technology to obtain even more information in the test center environment. Of particular interest are measurements of attitude of missiles and aircraft, measurements of miss distances of high-altitude missile and target engagements, detection of deployed objects, and determination of extent of damage (i.e, damage/kill assessment). In general, the requirement is to make measurements at high altitudes or long ranges where optical data are not available and where current instrumentation radars are incapable of making the measurements to the desired accuracy (e.g. miss distance to +/- 1 ft) or making the measurements at all (e.g. damage assessment).

Phase I: Research is required to determine the extent to which radar imaging technology is applicable to those measurements, to characterize the problems to be solved (e.g. resolution of individual scattering centers, elimination of acceleration smearing, stabilization of shifting phase centers, and identification and correction of multiple-bounce returns), and to specify the upgrades needed for the WSMR instrumentation radars and data processing facilities.

Phase II: Develop a prototype processor to make the radar images and extract the desired measurements. Some human intervention may be needed in the measurement process, but the prototype system should be as autonomous as possible, particularly in the arduous task of deriving the radar image from the coherent video data. Although the system will be designed for making measurements at long ranges, it should also work at the shorter ranges employed in many of the tests conducted at WSMR.

Potential Commercial Market: Development of this technology could expand radar applications for numerous commercial uses.

A-4 HIGH PERFORMANCE COMPUTING AND SIMULATION (I.E. MODELING DISPLAYS, AI, VIRTUAL REALITY)

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-037 TITLE: Fire Control Battlemanagement and Decision Support System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced software engineering and expert system decision aids technology for direct, indirect fire and smart mine field control. Develop embedded training for using the expert system decision aids for direct/indirect fire and smart mine field control applications.

DESCRIPTION: The feasibility of developing high performance expert system decision aids for direct and indirect fire systems and smart mine applications has been demonstrated recently based on laboratory prototype tests. Further technology development is required, however, to address specific algorithmic issues associated with real time planning/replanning, sensor/information fusion, terrain analysis, as well as issues of knowledge engineering, man/machine interface, rapid prototyping and simulation environments for evaluating decision aids. Expert system decision aids which address one or more of the following requirements are of specific interest: (a) Identification Friend or Foe (IFF); (b) Fire Control (acquisition/tracking); (c) tactical planning/order preparation; (d) tactical situation assessment; (e) status/reports; (f) self defense of weapon platform; (g) sustainment; (h) command and control (C2); (i) fire direction; (j) communication; (k) reconnaissance, selection and occupation of position; and (l) embedded training.

Phase I: Develop methodology for design and implementation of distributed expert system decision aids for direct/indirect fire and/or smart mine field control applications. Formulate and define conceptual designs for specific expert system modules including hardware implementation and software prototyping environment. Develop detailed functional specifications.

Phase II: Develop a full-up laboratory technology demonstration prototype decision support system with appropriate displays, simulation driven, development environment and run-time environment. Develop component-based software architecture and tool environment which will support reuse and reengineering of software components thereby reducing overall software development and maintenance cost of embedded decision support systems. Optimize hardware/software, algorithm and interface design based on laboratory test results and provide complete documentation of hardware/software, analysis and test results.

Potential Commercial Market: Developed technology has potential for commercial wargame products. In addition, required algorithm development in real time planning/replanning, sensor fusion, and terrain analysis can be used in commercial development of decision aids. Embedded training algorithms can be used on a wide variety of commercial software package offerings.

OSCR: Developed component based software architecture and tool environment will support reuse and reengineering of software components, thereby reducing overall software development and maintenance cost of embedded decision support system. Embedded training will reduce training cost on using expert system decision aids for control applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-042 TITLE: Position Location, Navigation and Fire Control Map Interface Unit

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an Operator Interface Unit for position location, navigation and Fire Control Systems based on the use of the current paper military map as the data base.

DESCRIPTION: A requirement exists for an operator interface unit for position/navigation (POS/NAV) and fire control equipment which is based on the use of the paper military map. The portable Global Positioning System (GPS) receiver, envisioned as the primary position and navigation device for military vehicles, will use a small alpha numeric operator interface. Position coordinates are read on a display and the grid coordinates of waypoints, etc., are entered via a keypad. The operator must manually make the association with his military map to locate his position or determine the grid coordinates of targets or waypoints. Each of these operations requires additional steps which are potential sources of operator error. Due to the importance of timely and accurate navigation for the successful conduct of highly mobile military operations and for the prevention of fratricide, a method is required whereby the POS/NAV system operator on a military ground vehicle can interface with the navigation system, principally the GPS receiver, using his most familiar and readily available navigation device, the military map. A unit is desired which would be a component of the ground vehicle POS/NAV system, uses the current military

map as its basis and allows the operator to locate his position, locate other positions, and perform other IO tasks directly from the map. Examples of functions to be performed are: locate present coordinates of any position indicated on the map, enter grid coordinates of a waypoint indicated on the map into the POS/NAV system; enter a series of waypoints defining an intended route of travel; recall a waypoint and indicate its location on the map for verification; indicate the range and azimuth to a designated location on the map from the vehicle's present position. The unit should accommodate military maps of various scales and be easily oriented. The size of the unit should allow convenient use inside a M1A1 tank or a Bradley Fighting Vehicle.

Phase I: Develop the design concept of the operator map interface unit including the systems interface to position location, navigation and fire control systems. Implement a conceptual broad board type system which operates in conjunction with standard military maps and uses existing military position location and navigation units of measure, coordinate systems operator interface procedures. Below for optional input, output and functional menus and functions to facilitate concept evaluation testing. Develop a preliminary functional system specification based on user inputs and test results.

Phase II: Produce several full-up modular-type units for application to different potential Army platforms and systems based on the Phase I preliminary specification. Support user testing and evaluation of the units. Optimize the design based on results of the user testing and evaluation. Develop finalized functional specifications.

Potential Commercial Market: The potential for commercialization is high. The use of such a map interface unit with a GPS position location system can be applied to a number of vehicle navigation situations. GPS navigation is being proposed for urban and inter-urban transportation vehicles, emergency vehicles, law enforcement vehicles, environmental management vehicles and even private use vehicles. It would have future use in survey and engineering applications for field data gathering and analysis.

OSCR: Unit has great OSCR potential. It would provide a very low cost interface unit to allow a much improved method for operators to interface with a POS/NAV system, GPS or otherwise based. It minimizes the use of high cost electronic display technology substituting a small alpha/numeric display and a conventional military map.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-048 TITLE: Neural Network Based Speech Identification/Transcription Module

CATEGORY: Exploratory Development

OBJECTIVE: Develop a neural network based voice recognition system that can identify and extract the speech of a single person from a signal containing other speakers and random noises, and then produce a transcription of the recognized words. Utilizing system completed in Phase II, expand the voice recognition system to include a full language based processing module to permit continuous real-time transcription of any grammar free statement containing any English work, from a chosen speaker in a harsh, high noise environment.

DESCRIPTION: Progress is slowly being made in the area of speech recognition, but as yet no system can work well in a noisy environment. This problem is compounded when the background noise is random or contains other voices. A voice recognition system capable of locking on to a speaker's voice would enable the system to be operated in a noisy environment and without a special microphone or headset which is currently required to acoustically separate the speaker from the environment. Artificial neural networks are currently being examined to solve this problem and appear to hold the greatest potential, but considerable amounts of conventional signal preprocessing may still be required. Technical issues of interest include noise reduction, speaker identification, language identification and language transcription.

Phase I: Develop methodology and approaches for enabling a neural network to learn and identify a designated speaker's voice in a signal containing other voices and random noises. Determine requirements for any signal preprocessing needed by the net, and provide system design specifications.

Phase II: Develop neural network based voice recognition hardware/software and development environment for interface with laboratory test bed environment. Develop test scenarios to demonstrate the recognition systems ability to learn and identify a designated users voice and transcribe what is said disregarding any random noises and other voices present in the signal. Provide fully integrated prototype module with documentation, source code and development environment and evaluate in laboratory test.

Potential Commercial Market: The results of this contract will conclude in the development of a product/system that will recognize and transcribe speech in a harsh, noise environment. Since current recognizers are designed to be used in a friendly, office environment this system will stand alone in its ability to transcribe commands and comments spoken on noisy factory floors, at construction sites, as well as in our battlefield and weapon crew station environments.

OSCR: Cost reductions will be realized due to the nature of voice control. It is natural, flexible and very high level and will therefore, reduce training time, increase crew efficiency and response time, as well as reduce total crew size.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-063 TITLE: Molecular Holographic Sensor

CATEGORY: Advanced Development

OBJECTIVE: Develop a prototype high resolution interference holographic Non Destructive Testing imaging system employing the organic light sensitive bacteriorhodopsin as the sensor medium.

DESCRIPTION: Hologram interferometry is used for studying the dimensional deformation of parts. A few possible examples are detection of wall anomalies in projectiles and cartridge cases, measuring the shape of cylinder bores, detection of residual stress and material fatigue, vibrational analysis of turbine blades, detection of disbonds in composites, and poor adhesion in epoxy laminates. Current methods employ holographic film as the sensor medium. Film is not realtime in that it must go through a development process. Also film is not erasable and reusable. Film does not interface well to digital encoding. These attributes severely limit possible real-time automated application of the technology. Bacteriorhodopsin has emerged as one of the most likely organic candidates for a molecular medium light sensor. The spectral transmissivity properties are appropriate for interferometry. Its image retention property is such to make it useful for real-time hologram interferometry, i.e., two images can be taken sequentially with no pause in time and the resulting interference pattern immediately seen and digitized. Images are formed immediately without a development process. Images can be erased in milliseconds and material immediately used to acquire a new image. Resolution is more than adequate for holography. Even though bacteriorhodopsin is an organic molecule, it is stable over many years. This solicitation is for the research and development of a new high resolution real-time interference holographic imaging Non-Destructive Testing (NDT) system. The system should use bacteriorhodopsin as the medium for the hologram. The system should have adequate speed, resolution, and range for real-time interference holography. The system should include a computer interface for digitally capturing the hologram. The system should be appropriate to use for NDT of munition items.

Phase I: The contractor shall investigate and prove the feasibility of making a high resolution real-time interference holographic NDT system as described above. The contractor shall find potential sources of venture capital for developing the "SBIR Phase III" market. The contractor shall design a prototype system to be build in Phase II. The proposal must show that the contractor has considerable prior experience with bacteriorhodopsin.

Phase II: The contractor shall build and deliver a prototype high resolution interference holographic NDT system with characteristics described above, test it, document its operational characteristics, validate its worth, and design a version rugged enough for use in a manufacturer's production facility.

Potential Commercial Market: A real-time erasable holographic medi does not currently exist. This project involves the development of such a media and its application to non-destructive inspection. Film, the current holographic media, has very limited real-time applications in automated NDI and even in pure holographic applications. An erasable holographic media will greatly expand possible applications.

OSCR: This office has clear evidence that automated NDI is more consistent and accurate than manual methods. This office will use the results of this project for inspection of munition items during or following the manufacture process. The result will be greater confidence in the quality, reliability, and safety of munition items before they are placed in the stockpile. Increased quality, reliability, and safety will lead to decreased logistic costs (fewer items will be required to achieve the same ultimate effect). A measurable effect should be a reduction in quantity of newly manufactured munition items that are suspended. The technique could be used under proper condition for inspection of already suspended items for such conditions as residual stress, cracks, fissures, and voids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-078 TITLE: Simulation Interfacing Techniques

CATEGORY: Exploratory Development

OBJECTIVE: The military has a large number of simulations, most of which cannot talk to each other. In order to achieve widespread use of distributed simulations, we need to look at ways to allow simulations to interact both horizontally and vertically.

DESCRIPTION: An example of such interaction is provided. The Corns Battle Simulation (CBS) must interoperate with the Air Warfare Simulation (AWSIM) on a horizontal basis. Some progress has been made using the DARPA-sponsored Aggregate Level Simulation Protocol (ALSP). Also, in the interactive distributed simulation arena, SIMNET and BDS-D objects need to exchange data. Again the DIS 1.0 standard is the first step in the process. However, linking CBS with BDS-D requires a level of vertical linkage not yet addressed. Further, large-scale linkage of many simulations/simulators may overwhelm the current approaches and available bandwidth. The Army urgently needs to address technical approaches to solving these interconnection issues. What are the appropriate technical approaches to these problems? Are current techniques sufficient? Do they need modification? Can vertical integration be done through protocols? What are good candidates? Are selected approaches scalable? What is the horizontal complexity, the vertical complexity, the combined complexity?

Phase I: Examine possible solutions to these interoperation needs. Provide the theoretical basis for solving this problem. Prepare a report addressing simulation interfacing needs.

Phase II: If appropriate solutions are found, demonstrate at least one solution by linking current selected simulations/simulators.

Potential Commercial Market: An interoperability standard/protocol will enable industry to offer enhanced simulations or new innovative simulations/simulators that will be compatible with a large number of others. This supports the military's move to open systems and standards.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-079 TITLE: Simulation Technology: Virtual Factory and Process Simulation

CATEGORY: Basic Research

OBJECTIVE: To develop new language constructs in support of "virtual" factory and process simulation.

DESCRIPTION: Through the use of the compiler-compiler technology, one can write "little languages" tailored to take high-level descriptions of engineering processes and convert these specifications into traditional target languages like C, C++, and FORTRAN. For example, to simulate a nonlinear control scheme, a language could be developed tailored to the terminology of feedback control. Similarly this idea could be extended for robotics, manufacturing technology, and process synthesis. Numerical algorithms could be described using mathematical objects which ultimately get targeted to efficient procedural languages for execution. Language recognition tools which make these projects easy to implement are needed to support the DOD/DA simulation initiatives. Object-orientation is strongly encouraged.

Phase I: Develop a suite of tools to aid rapid prototyping of process simulation. Demonstrate the approach with several examples using at least two different target languages.

Phase II: Extend the methodology to include graphical metaphors for language specification. The demonstration should model a full-scale industrial process with several hundred components. Optimization of process parameters or inverse modeling are examples of advanced applications expected for a phase II effort.

Potential Commercial Market: Optimization of manufacturing procedures or process design interests US heavy industry and the DOD. Most processes are tuned experimentally at great cost. Software tools which expedite the computer simulation of engineering problems are in great demand.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-086 TITLE: Optics for Head Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate reflective optic, binary optic, and/or holographic optic techniques potentially applicable to head mounted displays. Goals are for compact, high performance, inexpensive, light-weight, manufacturable optics to provide a (potentially transparent) display with an image projected at infinity.

DESCRIPTION: General - New concepts for providing visual information directly to the individual soldier including thermal images, video, maps, drawings, and text messages are limited by the lack of miniature displays that are acceptable in terms of cost, performance, reliability, size, weight and power consumption. This program should concentrate on alternative optic mechanisms for producing a miniature virtual image display.

Phase I: Phase I should result in an analysis of one or more approaches to miniature imaging system technology and identifying specific techniques with potential application to specific video generating devices. Simple proof-of-concept demonstrations of these techniques is a requirement and may take the form of static exhibits. However, translation of the

demonstrated approach must be reasonably shown to be applicable to high resolution displays. Selection of prototypes will be made and approaches will be determined which satisfy objectives that are representative of Army tactical situations.

Phase II: In Phase II, a prototype display device suitable for head mounting will be demonstrated. The approach will be evaluated for further refinement and incorporation in user specific demonstrations. The end products should be capable of demonstration with video camera and computer inputs. Approaches should be documented as to relevance to Army needs and how these techniques might be applied to Army systems.

Potential Commercial Market: Identified applications include the thermal weapons sight, Soldier's Integrated Protective Ensemble (SIPE), maintenance and logistics applications, and telepresence displays for robotics applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-092 TITLE: Interaction with 3-D "Virtual" Environments

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate hardware and/or techniques potentially applicable to providing interaction between human and machine for "virtual reality" and telepresence applications. Goals are for inexpensive, easy access, natural (instinctive) action means (hardware/software) for an operator to effectively interact with a "virtual" environment.

DESCRIPTION: General - New concepts which can provide faster, more natural response of the scene to operator inputs; better and faster tracking of operator movement; improved linking of audio to visual information; enhanced depth perception; and improved methods of sharing common head-mounted displays (where hygiene, size and vision accommodation are concerns). This program should concentrate on approaches which could ultimately be used by a single soldier on the battlefield.

Phase I: Phase I should result in an analysis of one or more approaches to improving interaction and identification of specific techniques with the potential to improve performance in virtual reality, cyberspace, or telepresence applications. Simple proof-of-concept demonstration of these techniques is a requirement and may take the form of static displays. However, translation of the demonstrated approach must be reasonably shown to be applicable to military requirements. Selection of prototypes will be made and approaches will be determined which satisfy objectives that are representatives of Army tactical and training situations.

Phase II: In Phase II, a prototype approach including hardware and software will be demonstrated. The approach will be evaluated for further refinement and development of or incorporation into a user- specific demonstration. The end products should be capable of demonstration with MSDOS or UNIX based computers with EtherNet, standard RS-232, and RGB or EGA/VGA video connections. Approaches should be documented as to relevance to Army needs and how these techniques might be applied to Army systems.

Potential Commercial Market: Identified applications include combat and maintenance simulators, mission planning stations, medical training, diagnosis and surgery, and telepresence displays for robotics applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-103 TITLE: Fire Support Suppression Effects in Battlefield Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To improve combat simulation models to account for the effect of nonlethal fire support.

DESCRIPTION: Fire support on the battlefield can destroy the ability of the enemy to act. As a result of fires, enemy personnel may be killed and their vehicles or weapons made inoperable, or personnel may be wounded--physically or psychologically--and their vehicles or weapons may sustain some degree of damage. In either case, the ability of the enemy to attack or defend is decreased. The extent to which suppression versus kills hinders the response of the enemy, has not been adequately quantified to be incorporated into fire support simulation. Typically, the use of fire support in simulations results in either a kill or no kill. When no kill is assessed, there are no other suppressive effects imposed on the enemy due to the delivery of fires. Suppressive effects caused by such things as (a) personal injury, (b) psychological stress, (c) equipment damage, (d) visual obscuration of the battlefield, or (e) navigational problems due to restricted visibility or cratering of the surrounding terrain need to be addressed in future simulation models. This weakness, inherent in the current simulation models, decreases the external validity of the simulation for fire support. Thus, in order to increase the utility of fire support simulation in MANPRINT-related studies, variables affecting fire support suppression must be identified and their singular and synergistic effects quantified.

Phase I: The purpose of Phase I will be to determine the feasibility of quantifying the nonlethal effect of fire support on personnel and equipment. This will include identifying the nonlethal effects of fire support on the battlefield and proposing a method for quantifying their impact on battlefield performance.

Phase II: The purpose of Phase II will be to select critical variables, from those identified in Phase I, and quantify their impact on battlefield performance. The resulting algorithms will be incorporated into the Target Acquisition Fire Support Model (TAFSM) maintained at the U. S. Army Field Artillery School (USAFAS), and a proposal to update the Janus simulations will be prepared for consideration by Janus software proponents, TRAC-White Sands Missile Range. Improvements to the Janus simulation software will allow the Army Research Laboratory to use the Janus simulation to examine weapon system performance during acquisition and product improvement phases.

Potential Commercial Market: Models and simulations for training and weapon system acquisition or enhancement are used extensively by both government agencies and private industry. The impact of fire support suppression on battlefield performance is not portrayed adequately in the currently available models and simulations. Thus, any improvements would be incorporated into existing models and simulations and used in the development of new systems.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-4

TOPIC: A93-105 TITLE: Development of Performance and Effectiveness Measures to Support Evaluations of Unmanned Ground Vehicles (UGV) Technologies and Operations

CATEGORY: Basic Research

OBJECTIVE: Develop test set-ups, methods of measure, data gathering, analytical tools, and methods of statistical analysis to study the important performance and effectiveness measures unique or particularly related to UGV technologies and operations.

DESCRIPTION: This effort would center on identifying and developing solutions to major difficulties in conducting experiments on human factors issues associated with remote driving and mission execution for UGV operations. The contractor will understand and incorporate current military UGV operational battlefield requirements and real-world terrain issues into performance and measurement criteria developed. The contractor will develop test design plans based on this criteria and will be required to identify the UGV operational issues resolvable by human factors studies and develop test course design ideas and test and analysis methods. The contractor will identify a range of studies and controlled test set-up procedures required to complete the studies developed, and demonstrate how these studies answer critical UGV technology issues. Study efforts will be directed to answer specific questions about augmentation techniques for a variety of UGV operations issues such as evaluating latency in video images and control over RF links, multiple cameras vs. single camera operational benefits, stereo vs. mono vision, and color vs. black and white displays. This list will be expanded under this effort.

Phase I: Identify the UGV battlefield operational issues and current UGV supporting technologies. Through a literature search of UGV testing completed to date, develop principal categories of measures required, identify the means of information capture and analysis. Propose specific approaches for development of the required capability to meet this Phase I objective in a Phase II effort.

Phase II: The measures, data gathering and analytical tools, and confidence measures will be developed, delivered and demonstrated for a specific UGV evaluation.

Potential Commercial Market: Opportunities exist within the UGV program in both industry and Government in the conduct of studies and evaluations of UGV technology effectiveness.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-146 TITLE: Quick-look Geometry and Vulnerability Description for Armed and Attack Helicopters

CATEGORY: Exploratory Development

OBJECTIVE: To be able to make "quick-look" estimates of vulnerability/survivability of armed and attack helicopters to various weapons systems.

DESCRIPTION: In order to get an early idea of effectiveness of a particular weapon system against a helicopter, or conversely to determine the survivability of a specific helicopter when attacked, it would be very useful to have an easy means of making "quick-look" assessments before performing in-depth analysis. The "quick-look" methodology requires a generic vulnerability/survivability database and also an easily modifiable geometry description. It must include a user-friendly graphics package, which would allow you to construct the helicopter on the screen of a PC and allow you to manipulate the database simply. The goal would be that given an attack helicopter and a weapons system, one could manipulate the existing vulnerability/survivability database and the geometry description to describe them and then come up with performance estimates. It should be emphasized that this tool would only be used to supply very preliminary performance estimates, but the detail would be sufficient to supply a reasonable idea of how to proceed with a more detailed analysis.

Phase I: Concept, approach and methodology should be demonstrated. A sample helicopter and vulnerability database should be constructed and a sample interaction demonstrated. The "user-friendliness" of the model and the graphics capability must be demonstrated.

Phase II: After demonstrating the feasibility of the "quick-look" techniques in phase I, the methodology should be extended to both foreign and U.S. helicopters and weapons systems. The ability to model several classes of armed and attack helicopters should be achieved and the database should contain descriptions of a variety of U.S. and foreign weapons systems.

Potential Commercial Market: This technology and approach could be extended to vehicles and structures. As a preliminary design and decision tool it would be valuable if shared with or transferred to defense contractors. This supports the concept of smart design engineering and simulation before entering into expensive prototyping and testing.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-155 TITLE: Graphical User Interface for Finite-Element Based Comprehensive Rotorcraft Analysis Software

CATEGORY: Exploratory Development

OBJECTIVE: The development of a user friendly, graphics-based interface for comprehensive rotorcraft analysis software.

DESCRIPTION: In recent years, there has been significant progress in developing computational methods for comprehensive rotorcraft analysis. These methods have been introduced into computer codes, which permit the rotorcraft industry to perform increasingly complex and realistic analyses of complex rotorcraft aerodynamics and structural dynamics phenomena. Unfortunately, using these new codes is often quite cumbersome because of the need to supply the large quantities of data needed to define the major components of the rotorcraft model (i.e., structural model, aerodynamic model, control system model), and to guide the complex solution algorithms. The Second Generation Comprehensive Helicopter Analysis System (2GCHAS) is a large, multidisciplinary, computer software system designed to analyze the performance, stability and control, aeroelastic stability, loads and vibrations, aerodynamics, and acoustics characteristics of rotorcraft. Developed by the Army to provide a significant increase in rotorcraft analysis capability, 2GCHAS provides state-of-the-art capability in modeling and analysis. 2GCHAS uses finite element methodology to analyze structural dynamics, and will be adding Computational Fluid Dynamics (CFD) capabilities for enhanced aerodynamic analysis. In 2GCHAS, the use of menu-driven selection, coupled with formatted data entry screens and help files, offers some on-line guidance to the user, but the menu hierarchies can be confusing to the user. The personal computers and workstations that have recently appeared incorporate novel, graphics-based user interface concepts that, when applied to comprehensive rotorcraft codes, could dramatically enhance user interfaces with these codes. The novel concepts include multiple-window environments, pull-down menus, mouse-driven selection of software options, and the use of interactive color graphics to display user input data as well as analysis results.

Phase I: Perform the conceptual design of a graphical user interface for a finite element-based comprehensive rotorcraft code. Present the design in the form of a draft user's manual that should focus on how the graphical aspects of the user interface will operate. Also present a demonstration of the graphical user interface with a typical comprehensive rotorcraft analysis problem.

Phase II: Implement the graphical interface with the 2GCHAS. The software shall be designed using the Structured Design Methodology, and the final deliverables shall include the software, complete User's Manual, and the design documents mandated by the design methodology.

Potential Commercial Market: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. 2GCHAS provides that capability. This capability could be applied to all new commercial designs and product improvements reducing design and analysis cost and time as well as integrating a wide range of technical areas during design optimization.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-160 TITLE: Expert Systems Conflict Resolution

CATEGORY: Exploratory Development

OBJECTIVE: Develop analytic means to categorize conflicts in expert system guidance and suggest concrete methods for potential users to resolve such conflicts.

DESCRIPTION: Military and civil aviation flight decks are seeing an increasing trend toward applying model-based aiding systems to facilitate aircrew performance in a number of domains. Within the military, navigation and route-planning expert systems have been developed for optimizing cover and threat avoidance, while similar systems exist for commercial aircraft diversion logistics and weather avoidance. Fault diagnosis, system maintenance, and fault recovery reconfiguration expert systems are becoming increasingly sophisticated on both civil and military platforms. Information management systems are being prototyped to deal with the profusion of communication and information exchanges made possible by improved transmission and display technologies. Unfortunately, each of these model-based systems is being developed in relative isolation. A significant challenge yet to be addressed is the integration of these model systems in a dynamic environment. Individual model update rates must be coordinated and references to other expert system models must be explored in order to avoid the likely condition of conflicting system advice. A reported incident in relatively low-tech commercial aircraft operations illustrates the problem. While in a multiple aircraft holding pattern, a TCAS (Traffic Collision Avoidance System) issued one of the aircraft in the pattern an executive level alert to dive. A subsequent cascade of dangerous actions resulted from the tightly coupled nature of the operations system. Similar precision and tight operational tolerance is experienced in the flight deck. Methods must be investigated to assure that conflict resolution among highly automated systems is not simply left to the flight crew or the ground operations controller. Information concerning the interaction of joint automated experts should be supplied to the human operators of those systems if they are to have the responsibility for coordinating and deconflicting them. An analysis method is required to determine by what information, time frame, protocols, and procedures is the human operator to deconflict expert guidance. We are entering a system environment in which the current standby "turn it off" is no longer an acceptable option.

Phase I: Complete study of documented guidance conflicts within fielded and near operational expert systems. Categorization, along temporal and logical dimensions, of "typical" conflicts. Describe and abstract principles from "ideal" human intervention in resolving such conflicts. Document findings in a report.

Phase II: Develop working software prototype which guides a novice user through resolving conflicting expert system guidance in an aviation domain example. Develop techniques for depicting and predicting logical conflicts within embedded knowledge of inhomogeneous expert systems. Prototype software tool embodying these techniques.

Potential Commercial Market: While the aviation environment motivated this SBIR topic, the methods for safely handling conflicts in expert system guidance would see widespread application. Truth maintenance and debugging systems for single platform, single domain expert systems are in widespread use today as part of the system's development environment or shell. Tools for accomplishing the stated objectives would find similar commercial viability as the use of multiple, cooperating expert systems proliferates.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-164 TITLE: Application of Parallel Processing Technology to Complex Helicopter Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Develop parallelization techniques for complex helicopter analysis systems to expedite processing and output.

DESCRIPTION: Complex helicopter analysis systems are being developed and implemented to provide a significant increase in rotorcraft analysis capability. These large, multidisciplinary software systems are capable of analyzing the performance, stability and control, aeroelastic stability, loads and vibration, aerodynamics, and acoustics characteristics of rotorcraft. The

systems use finite element methodology to analyze structural dynamics and will be adding Computational Fluid Dynamics (CFD) capabilities for enhanced aerodynamic analysis. The major limitation on their effectiveness is the slow processing that results from the computational intensity of the modeling and analysis software. Efforts are currently under way to improve the computational efficiency through improving the algorithms and data access methods. Future versions will require additional significant increases in processing speed in order for them to achieve their full potential as design optimization tools. Parallel processing technology offers a cost effective approach to increasing performance by distributing the computational load over multiple processors. Proposals are sought to investigate the opportunities for parallelization, and to demonstrate the implementation of parallel processing methods to expedite processing of complex analysis models.

Phase I: Identify and evaluate specific opportunities for parallelization of helicopter analysis systems, and estimate performance on selected parallel computer systems.

Phase II: Produce an efficient parallel implementation of a complex helicopter analysis system on an appropriate parallel processing computer system.

Potential Commercial Market: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. These software systems provide that capability. This capability could be applied to all new commercial designs and product improvements reducing design and analysis cost and time as well as integrating a wide range of technical areas during design optimization.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-168 TITLE: Methods for Pre-Flight Risk Assessment in Army Aviation

CATEGORY: Exploratory Development

OBJECTIVE: Determine the factors and combinatorial rules to accurately predict mission risk in Army aviation. Several criteria for these factors and rules must be met. They must be: 1) readily available; the pilots must not be delayed trying to determine mission risk, 2) easily and quickly input to a calculational or computational system capable of rapid response, 3) diagnostic; taken together they must accurately predict a region on a risk distribution where this mission would fall, and 4) sensitive; a change in one of the factors should affect the overall risk prediction.

DESCRIPTION: Much of the groundwork is laid for performing preflight risk assessment in Army rotorcraft through the automated systems designed for Emergency Medical Services (EMS) in the civil sector (Shively 1992). Extensions to this approach would be of direct benefit in the Army aviation environment. However, elements which contribute to a quantification of risk in the Army domain can be much different from civil counterparts, such as flying nap-of-the- earth or with night vision goggles. This effort will research and identify those factors in today's Army aviation which contribute to risky missions, and then use these factors to develop a decision aiding system for operational aviators. Some of the required information for such a system may be available through the review of accidents and incidents. However, this is a select database--risky missions often do not result in accidents. Therefore, a study performed at operational units is appropriate for a useful tool. Once adequate data is gathered, modeling the subsequent findings may result in a simple linear regression, if that captures enough of the variance. Otherwise more complex combinatorial rules will also have to be explored. The chosen knowledge and methodology can then be embedded within an automated system and subjected to validation studies. The decision aiding system resulting from this topic will help to determine, objectively and reliably, if the risks of a potential mission are outweighed by its benefits, as well as aid with material allocation, (i.e., two helicopters may reduce the risk to acceptable levels). Such a system can also be used to indicate when a higher authority is needed. For example, under low risk conditions the pilot may have authority to approve the mission, while higher risk sorties may dictate approval by the company commander prior to flight.

Phase I: This phase would consist of: 1) initial data collection, literature review, 2) studies at operational units to investigate factors leading to risky missions, and 3) initial development of the candidate algorithms to combine the factors to predict the risk of missions.

Phase II: This phase would consist of several parts: 1) testing and selection of the most appropriate combinatorial rules, 2) the development of the software and interface that would serve as the pre-flight risk assessment system, and 3) preliminary validation studies.

Potential Commercial Market: The commercial application and interest for this topic is demonstrated by the present work (performed) in the EMS industry). A similar topic was also chosen for a joint research initiative between NASA Ames and a commercial partner. Once a system such as this has been developed, it may logically be extended to other services and environments. Spin-off systems for the Navy, Air Force, or Coast Guard as well as markets in general aviation and air transport may also be of substantial value.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-170 TITLE: Intelligent Information Presentation for a Helmet Mounted Display in a Synthetic Environment

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative and intelligent information presentation for a Helmet Mounted Display (HMD).

DESCRIPTION: Future methods of providing appropriate and timely information to the rotorcraft pilot via an HMD will require significant improvements to meet mission and pilotage requirements. Categories of information already envisioned for the HMD include flight, weapon, target acquisition, navigation, system, obstacle avoidance, virtual switching and warnings. Research has shown that this would lead to pilot information overload. Advances in inteingent information presentation as well as prioritization and filtering of flight mode information needs to be achieved to obtain an essential high level of performance during low altitude night operations. Manual mode selection of display information in use today was developed in the late 1970s. Manual mode selection does not take advantage of data bus and electronic cockpit monitoring systems that could provide automatic and intelligent information updates. Manual mode switching also increases pilot workload and often results in unnecessary display icons that clutter the pilot's synthetic environment. Current technology does not provide the intelligent information presentation requirements necessary in future aircraft.

Phase I: Using several design principles, identify and evaluate innovative flight and mission information mode switching concepts necessary for Army Aviation. Then, using a baseline which is representative of current technology, select several candidate intelligent information prioritization/filtering techniques to demonstrate the potential increase in pilotage and mission effectiveness.

Phase II: Preliminary evaluations of intelligent information presentation concepts for a HMD will be performed in both ground and in-flight simulation to verify improvement potential. Complete definition of intelligent moding characteristics of the most promising configuration will be verified in flight tests on helicopters with HMD systems.

Potential Commercial Market: Developments in intelligent information presentation have vast potential commercial market applications. Proper information presentations is a critical operational safety and mission performance issue in both commercial helicopter and fixed-wing markets. Technology developments and lessons learned through this effort could be readily applied to address these issues.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-171 TITLE: Application of Virtual Reality to Helicopter Target Acquisition, Pilotage and Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Develop an application of virtual reality technology for helicopter target acquisition, pilotage (on board and remote) and simulation.

DESCRIPTION: As the laser and other directed energy threats on the battlefield increase, there will be a need to reduce or eliminate the crew's direct optical link to the outside world. An improved method of providing the crews scene, target, and flight data will be required. Virtual reality technology is revolutionizing the way in which man and machines interface and the way in which data may be presented to operators, acquisition and pilotage (onboard and remote) capability. Furthermore, virtual reality technology may offer a significant operational and support cost savings in the development and use of aircraft simulators, potentially eliminating the need for expensive fixed simulator facilities and offering the capability to provide a computer driven, virtual reality based reconfigurable simulator at each airfield.

Phase I: Develop a limited laboratory demonstration of the application of virtual reality to helicopter target acquisition, pilotage, or simulations. -Assess the state of the art in virtual reality technology. -Define potential applications for virtual reality. -Assess the requirements to demonstrate these concepts. (To include computing power, hardware, software, etc.) -Conduct a limited laboratory demonstration of a selected application. -Define an application for comprehensive demonstration in Phase II.

Phase II: Develop virtual reality application for a specific mission and demonstrate the concept in a ground based system.

Potential Commercial Market: Virtual reality technology will have a significant commercial market from video games to robotics. Development of a pilotage or simulator capability will have commercial application in the aerospace indopace ind

TECHNOLOGY CLUSTER: A-4

TOPIC: A93-172 TITLE: Light Weight Small Volume Stereoscopic Visual Sensors for Telepresence on Robotic Rotorcraft Research Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To allow the ground-based human pilot of a remotely operated rotorcraft research vehicle to project their sensory, motor and cognitive skills to a remote location, thereby giving them the sensation of being present at that location in the cockpit of the flight vehicle. The faithful reproduction of sensory information, and the degree to which the command and control infrastructure is rendered transparent to the operator determines the fidelity of the telepresence experience. However, all of the characteristics mentioned above need to be accomplished by onboard sensors that are severely limited in size and weight.

DESCRIPTION: The proposed effort is to be part of the Free Flight Rotorcraft Vehicle (FFRRV) program being conducted jointly by the US Army and NASA Langley. The FFRRV program is developing the technology to perform dynamic agility, stability, control, and acoustic research using instrumented, free flight, reduced-scale powered rotorcraft models having Mach-scaled wind-tunnel model rotor systems. The free-flight rotorcraft program is in part an outgrowth of the fixed-wing drop model program which has become an essential part of the development of all high-performance military aircraft. The significant difference between the rotary-wing and fixed-wing programs is that the helicopter models must be powered and are therefore subject to all of the dynamic handling quality issues of full-scale helicopters, but amplified by the smaller scale of the research vehicle. Development of a telepresence capability can provide the model helicopter research pilot with considerably enhanced sensory environment, necessary for nap of the earth flight (NOE). Although the telepresence research is to be conducted on helicopter models, the technology is wholly transferable to the fixed-wing activities at Plum Tree, and to the UAV, flight test, and robotic communities at large. Even though there have been a number of studies aimed at providing remotely controlled systems some measure of telepresence capability, the technology is immature and there are few precedents on which to rely for guidance. However, it is widely recognized that stereoscopic vision with a field of view around 180 degrees will be desired. Although high resolution is only needed in a small range around the focal point of the eyes. Moreover, the technique has never before been attempted at this scale for research flight vehicles having the level of performance expected from the Free-Flight Rotorcraft Research Flight Vehicle (FFRRV), and there are several unknowns in solving the telepresence problem. For example, the required tracking rates and damping characteristics for vision systems needed for flight operations are not well defined. These are also severe video sensor system weight and size constraints on unmanned vehicles of this scale. This technology offers not only enhanced research capabilities for model flight research conducted at Langley, but also has exciting implications for full scale flight testing, hazardous environment operations for all forms of automotive vehicles, combat, reconnaissance, and surveillance activities, and robotic applications.

Phase I: The expected results of the phase I SBIR would be the complete design of the stereoscopic video sensors, the control system for the helmet tracking system to steer the sensors, and a telemetry system for the transmission of the stereoscopic video data to the ground station. This design must be sensitive to the volume, and weight restrictions of the free flight research vehicle.

Phase II: Phase II would be the manufacture and test of the complete system incorporated into FFRRV.

Potential Commercial Market: The commercial market for robotic vision devices is vast. In particular, civil ground transportation and manufacturing applications would directly benefit from the technology developed through this effort.

TECHNOLOGY CLUSTER: A-4

TOPIC: A93-198 TITLE: Modeling of Automatic Target Recognizer Performance

CATEGORY: Exploratory Development

OBJECTIVE: Develop a systems level model which provides accurate predictions of ATR performance.

DESCRIPTION: Current capabilities for modeling system performance of thermal imagers cover sensor design and the human operator. In the case where an automatic processor does all or part of the target acquisition process, the statistics of past experiments and testing are the only tools available for predicting future performance. A model is required which encompasses both human and processor performance.

Phase I: Outline an original methodology for the understanding and prediction of automatic target recognizer performance. Limited government test data will be made available by the government since some of the material is classified. A security clearance would be advantageous, however, a security clearance is not required for this effort.

Phase II: The methodology outlined in Phase I will be formalized into a mathematical model and computer code. A more extensive validation against test data will be accomplished.

Potential Commercial Market: The model and computer code developed in Phase II can be used by commercial developers of ATR's to measure the efficiency of their current algorithms and guide the development of improved algorithms.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-208 TITLE: Contextual Benchmark Features for use within AI Scripts

CATEGORY: Basic Research

OBJECTIVE: Develop a mathematical proof which proves or disproves the existence of contextually sensitive features within scripts, which, if they exist, may be used to ensure the robust and accurate flow of contest between script elements. This technique would become part of a tactical threat assessment system. It's function would be to evaluate the relevancy of a tactical script hypothesis to instantiated battlefield data.

DESCRIPTION: AI-based planners and plan recognition algorithms frequently make use of scripts to establish context and context expectation. Many researchers believe that humans are able to accurately navigate within a script by identifying contextual features within the current context which provide benchmark information to uniquely identify the context. This effort will develop the necessary mathematics to prove or disprove the existence of the hypothesized benchmark features. If such features can be shown to exist, the remainder of this effort will be focused on the development of an algorithm which can automate the benchmark feature selection process, as a function of script, and make use of this information to accurately navigate inter- and intra-script contexts.

Phase I: Development of mathematical proof which will prove or disprove the existence of contextual benchmark feature information as described above.

Phase II: If the existence of such benchmark features can be proved, automate the benchmark feature selection process, as a function or script, and show that this information can be used to accurately navigate inter- and intra-script contexs.

Potential Commercial Market: This technique should find wide applicability in military, space, and industrial usage where robotics is employed.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-221 TITLE: High-Speed Transient Waveform Acquisition System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a single-board, high-speed transient waveform acquisition system to acquire and process multiwavelength IR LIDAR data in real time.

DESCRIPTION: Light detection and ranging (LIDAR) systems used in chemical remote sensing applications require very high digitizing rates (50-100 MHz), good dynamic range (10-12 bits), and large amounts of memory for waveform storage (2 Megabytes). Multiwavelength LIDAR systems require that the data acquisition system have a high throughput rate and special triggering modes. These systems also demand the capabilities of on-board modes. Currently available technology is limited to digital oscilloscopes connected to slow interfaces such as GPIB which seriously limit system throughput. A compact programmable single-board approach is desired which can be inserted into a standard high-speed bus such as EISA or VXI.

Phase I: The contractor will study the acquisition and processing requirements in detail and present the most promising solutions. Key issues to be investigated include bus interface, choice of operating system, on-board digital signal processing (DSP), digitizing and dynamic range tradeoffs, market trends on A/D technology, and ease of system upgradeability as A/D technology matures. An approach will be chosen based on the most desirable solution and a single prototype will be designed.

Phase II: The contractor will fully debug and implement two working data acquisition systems designed in Phase I. Special attention will be placed on perfecting and hardening the actual circuit design of the main acquisition board. Issues such as EMI susceptibility and protection will also be studied at this time.

Potential Commercial Market: WIll make available to the waveform acquisition and digital oscilloscope market a high-end single-board digitizing capability not currently available.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-233 TITLE: High Explosive Structural Damage Assessment Model Computer Code Enhancement

CATEGORY: Advanced Development

OBJECTIVE: modify, enhance, verify and document the high explosive structural damage assessment model (HEXDAM) to provide a public release code for use in preparing explosives safety site plans.

DESCRIPTION: A major component of the logistics cycle costs for ammunition and explosives is the investment and maintenance costs for the structures and real estate required to store these items. Reduced costs for real estate (explosives safety buffer zones) and protective construction designs can be realized if a verified high explosive structural damage assessment model were available to the local commands for the preparation of explosives safety site plans. The HEXDAM code can be improved to fulfill this requirement. The improved computer code with documentation would be developed as a public release product to be approved by the DDESB for use in preparation of explosives safety site plans.

Phase I: This phase modified the computer model to expand the applicability. Develop an unclassified library of up to 20 typical structure types. Vulnerability parameters are to be derived based on pressure-impulse (P-I) diagrams for structural elements, e.g., walls, slabs, beams, columns. Work is to include developing a methodology for creating composite P-I diagrams and/or vulnerability parameters for each typical building type, based on addition or superposition of P-I diagrams for individual building components. This methodology is to be used to define the structure types in the library. Develop an automated process for defining new structure types, using the methodology developed above.

Phase II: This phase enhances, verifies and documents the computer model. Perform a study to validate the program's prediction of damage using the structures defined above. This study should compare damage levels (percent damage) predicted by the program with damage actually observed in explosive tests or accidents. Develop a guidance document that defines and describes what the predicted damage values for each of the predefined structures ac...lly means in terms of percent physical damage, e.g., broken windows, roof or wall panels blown off, buckled roof beam... ...aluate the existing structure-to-structure shielding algorithms in the program. Determine if the methodology used by the code realistically predicts the effect one structure has in shielding another structure from blast wave effects. Expand the program capabilities from two-dimensional (2-D) to 3-D problem definition and solutions. This would include input and output, color graphics, and overpressure and damage contours, computer and plotted in either two or three dimensions. Add a mouse-driven user interface.

Potential Commercial Market: As a public release, unlimited distribution computer code with documentation this product will be available to the commercial architecture and engineering community for providing technical support for preparation of DoD, Department of Energy, and NASA explosives safety site plans.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-262 TITLE: Human Operator Model Baseline Architecture Simulation (HOMBAS)

CATEGORY: Advanced Development

OBJECTIVE: The objective of this effort is to identify a knowledge level architecture in which components of a predictive Human Operator Model (HOM) can be integrated and operate to demonstrate intelligent behavior. The intelligent behavior will be in response to a specific dynamic and environmentally relevant stimulus. Components of the HOM include: human sensor functions (visual, audio, smell, feel, taste), cognitive (cognition, perception, memory, rule based reasoning, mental model reasoning), and motor behaviors (physiological and motor functions). The modular structured and objected oriented architecture and integrated HOM components will be demonstrated through the use of a computer based simulation to be developed by the contractor.

DESCRIPTION: The majority of Human Performance Models (HPM) are developed to: demonstrate theories of human performance, or to assist in the design of equipment, or help establishing equipment configuration. An example would be a model of human vision to assist in design and layout of a man-machine interface for a specific system. The task here is not the development of a HPM for equipment or system design. The emphasis will be on the development of an architecture and human operator models that demonstrates intelligent human behavior and can serve as an input to existing system simulation models. An example of an HOM applications would include replacing a human in a Person-In-The-Loop Simulation for a specific application and system analysis. The architecture will be modular structured and object oriented to permit the integration of developmental models and existing HOMs that were developed using traditional modeling methods that include: information processes approaches; control theory approaches; task network approaches; and knowledge-based approaches (See reference: Quantitative Modeling of Human Performance in Complex, Dynamic System, Eds. S. Baron, D.S. Kruser, and B.M. Huey, Panel on Human Performance Modeling, Committee on Human Factors, Commission on Behavioral and Social Sciences and Education, Nation Research Council, Nation Academy Press, Washington D.C. 1990, ISBN 0-309-04135-X). The computer based simulation developed to initially demonstrate the architecture and HOM operation will be developed for a 486 (or higher) PC type computer and will use the NASA developed CLIPS Version 5.0 or above for the simulation development environment. Through the use of the HOM in conjunction with person-in-the-loop simulation, Operation and Support Cost Reductions associated with Software Maintenance/Support Costs can be achieved.

Phase I: This phase will include identification, design and prototype development of a knowledge-type architecture for integrating the HOM components. Simplified models of HOM components will be used to demonstrate the modular structured, object oriented architecture. The demonstration will be a PC computer (486 or higher if available) and Clips 5.0 or higher.

Phase II: This phase will produce a matured object oriented, modular structured architecture for integrating and developing HOMs that will demonstrate intelligent behavior. The intelligent behavior will be in response to a specific dynamic and environmentally relevant stimulus or screnario. Components of the HOM will include combination of existing models and developed models as indicated in the objective of the task. The contractor will deliver to the government a demonstration system that includes: the modular structured, object oriented architecture; human operator models, any non-developmental software packages and specially developed software required for system operation; the operating platform necessary for full up demonstration.

Potential Commercial Market: Training system development; Prediction of human responses in a dynamic and stressful environment. The study and evaluation of surrogate member operation in a multi-member team operating environment.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-263 TITLE: Computer Aided Software Engineering (CASE) Tool for Software Maintainability Feedback for Software

CATEGORY: Advanced Development

OBJECTIVE: Integrate metrics into a CASE tool such that a parametric definition of software design features drives software under development towards optimal maintainability.

DESCRIPTION: A software development CASE tool is developed which is specifically for object oriented Ada and includes features to automatically adjust the architectural structure of the software based on parameters reflecting maintainability (modifiability). Provisions must be included to tune the model based on data collected from maintenance efforts on the code. This effort supports Operation and Support Cost Reduction generic cost driver, "Software Maintenance/Support Costs" in three aspects: it improves software CASE tools, it enhances the software engineering process, and it utilizes software metrics.

Phase I: Build into a graphics based object oriented Ada CASE tool metrics which can be used to tune software during development.

Phase II: Demonstrate the operability of the tool and enhance it's operation based on commercial or military software projects.

Potential Commercial Market: This technology would allow software developers to design software production lines which measure the product as it is being developed so that, by tuning the process and the product in real time, an optimum software product would be produced.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-265 TITLE: Logistics-Sustainment Technical Assessment Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Develop simulations that will permit the assessment of technology innovations and improvements in logistics and sustainment systems ranging from industrial base through combat conditions, that can be hosted on a variety of platforms ranging from PCs to workstations, and fully interfacing with Battlefield Distribution System (BDS) at all levels from individual weapons' systems through Corps.

DESCRIPTION: Modern technology offers great potential improvements in reading and sustaining America's Army. With the advent of the Louisiana Maneuvers, Forward Projection, and tailorable forces, the need for critical analysis and interplay tools/simulations that accurately portray the production, stockpiling, transport, distribution and use of equipment, spares, and supplies is a must. Modern object oriented programming techniques offer great potential for a contemporary, advanced analysis tool and simulation that will facilitate the comprehensive assessment of modern technologies applied to logistics and sustainment at all levels from individual packages/systems through organizational and control methodologies. This capability is fundamentally necessary to provide a cutting edge, high technology logistics instrumentality that is optimally responsive to the demand of tailorable forces and force projection. Additionally, the depth and comprehensiveness of this simulation/tool will afford unprecedented capability to identify O&S cost drivers and analyze technological and organizational alternatives for their reduction (i.e. OSCR).

Phase I: Within the framework of current and future comb t simulations, including the interactive BDS, the analytical requirements of the DoD 5000 series and Army regulations, and the capabilities of modern technology applied to logistics, conduct a comprehensive review of existing logistics and sustainment simulations and models. Develop a practical object oriented architecture for a modular logistics simulation and demonstrate proof of principal with a limited problem set.

Phase II: Apply the Phase I architecture at a practical level of implementation ranging from CONUS depot and (aggregated) production base through at least Corps level distribution. Demonstrate interface with an analytical Corps level simulation (e.g., VIC or EAGLE) and with BDS (e.g. CBS).

Potential Commercial Market: The Phase II portion of this effort should develop and incorporate artificial intelligence, virtual reality, and advanced graphics techniques in order to achieve maximum user interface, visualization of the logistics systems, dynamic reaction of the simulation to the logistics situation, and training feedback for logisticians. These fields are on the leading edge of computer science technology and have tremendous potential for any business interested in simulation and improvement of their processes and training of their personnel.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-267 TITLE: Man-In-The-Loop Trainer for Non-Line-of-Sight Combined-Arms (NLOS-CA) and The Army Combined Arms Weapon System (TACAWS)

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-271 TITLE: Improved Missile Guidance Simulator Target Position Control for Precision-Guided Weapons

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-275 TITLE: Software Assemble Expert System

CATEGORY: Advanced Development

OBJECTIVE: Development of an expert system to assemble predefined Ada software packages into customized guided missile systems.

DESCRIPTION: The automated software generation expert system would select from predefined sets of generic software for missile systems. Select parametric valves for the parts, and assemble them into a customized missile system software package. This effort supports Operation and Support Cost Reduction by reducing generic cost driver, "Software Maintenance/Support Costs" in two areas: It improves software process model and it enables a powerful reuse concept.

Phase I: Integrate automated software domain analysis with AI expert system techniques to build from Ada software parts repositories, as software system for generating tactical missile code and test cases.

Phase II: Construct and test variations on software for several tactical missiles to fine tune the parameteriztion process.

Potential Commercial Market: This technology would allow commercial and military "software parts houses" to be developed for many different application areas. Simulation, communications and engineering sciences using compute software could have extensive software parts inventories if the technology were available.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-281 TITLE: Application of Neural Network & Fuzzy Logic Theory To An Autotracker Design

CATEGORY: Exploratory Development

OBJECTIVE: Increase the robustness efficiency and performance (accuracy, stability, target discrimination and identification, etc.) using neural network and fuzzy logic theory to implement an autotracker design.

DESCRIPTION: The neural network/fuzzy logic implemented autotracker must "learn" to distinguish between the target and 1) background clutter (foliage, trees, bushes, etc.) and 2) countermeasures (flares, etc) & obscurants (dust, smoke, etc.). Once

a target is selected, this protypical autotracker must "lock onto" the target, ignoring any other objects which may pass in front, behind, or adjacent to the selected target. The solution approach dictated for this Small Business Innovation Research inherently produces both a development cost reduction and also an Operation and Support Cost Reduction for Software Maintenance/Support Costs. An important by-product of neural network and fuzzy logic methodologies is a decrease in the mathematical scope and complexity and an increase in the prototypical (incremental) design technique's frequency, resulting in a decrease of the time and labor (cost) necessary for the intensive and intricate design/maintenance analysis. Cost reductions will also be realized by: using less expensive sensors and microprocessors; the ability of such an item to "learn to adapt" to it's environmental cues; the ease in modifying the system through changing: either the rules describing the system's operation, using natural language, and/or the graphical representation of the system; and the increased stability, robustness, and efficiency of the system (when compared to conventional and/or man/machine systems). Finally, nonlinear physical systems are extremely difficult to model mathematically and only neural network/fuzzy logic techniques may produce the required solutions for these types of systems.

Phase I: Given the functional description and the algorithms/equations for a generic autotracker, determine which functions and algorithms/equations can be implemented using neural networks and/or fuzzy logic techniques. Compare the neural network/fuzzy logic implemented autotracker design with a conventional autotracker design (for accuracy, stability, performance) by analysis and/or simulation.

Phase II: Establish the requirements and the design for a neural network fuzzy logic implemented autotracker for a protypical laboratory model which can demonstrate it's design soundness and functional capabilities (robustness, efficiency,and performance).

Potential Commercial Market: There are many commercial and Government "spinoff areas" which could result from the development and implementation of "NEURAL NETWORK & FUZZY LOGIC THEORY TO AN AUTOTRACKER DESIGN". A few of these are:

A. Terminal guidance techniques and methodology which can be applied in any "docking" and/or "maneuvering" situation; e.g., space vehicle docking and maneuvering. The use of advanced technology could make "docing" and/or "maneuvering" more efficient and accurate--no oscillation and/or overshoot.
B. Image enhancement and identification systems.
C. Robotic systems.
D. Unmanned Vehicle Navigation and/or Homing Systems (Land, Air, and Sea).
E. Surveillance and espionage systems.
F. Missile Weapon Systems

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-306 TITLE: Fusion of Kwajalein Missile Range (KMR) Optical and Radar Data for Enhanced Deep Space Surveillance

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-308 TITLE: Global Positioning System (GPS) Error Modeling for Incorporation into Post-Mission Trajectory Estimation

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to determine an error model for recorded GPS/TPS data which can be used to optimally correct and combine the GPS position and velocity solution with ground based radar and optical data.

DESCRIPTION: More and more frequently, missiles, aircraft and other vehicles are equipped with GPS translators which receive signals from the GPS satellites and retransmit them to a ground station (TPS), where they are processed into a real-time position and velocity solution. Although the processing is done in real-time, some intermediate results are also recorded and are available for post-mission analysis. Since position and velocity information are also available from numerous ground sensors, the best trajectory estimates should be obtained by combining the GPS data with the data from the ground sensors. In order to do this in an optimal manner, it is necessary to have error models for both the GPS and the ground sensor data. Error estimates of the GPS position and velocity are supplied as part of the real-time solution; however, these errors are the result of a complex processing procedure which prevent the user from assessing the validity of the output errors, modifying any of the input components, or determining concomitant information such as time correlation.

Phase I: Investigate the error model used in the current GPS TPS solution to isolate the basic input error parameters and quantify them. Determine the mathematical models used to propagate these input errors into the final position and velocity errors. Determine which errors can be reduced by post-mission processing and quantify the expected improvement.

Phase II: Develop a practical method by which GPS data and ground sensor data can be combined in a trajectory estimator in a reasonably well balanced manner. This phase of the study should address such issues as: methods of combining the highly correlated GPS solution with the relatively independent radar and optical sensor errors; identification of significant GPS error inputs which can be corrected and/or estimated in a post-mission environment, and the possibility of estimating GPS error parameters via post-mission regression analysis.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for use of error model for estimating trajectories.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-309 TITLE: Film-to Video Conversion

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-317 TITLE: Visual Data Base Feature Extrapolation

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods which are applicable to visual simulation data bases for "filling-in" specific building structural features when appropriate photographic data is not available.

DESCRIPTION: From a comprehensive set of photographs of an area of interest a visual data base for visual simulation purposes can be created. There are practical cases where the required photographic data is either not available or incomplete but the training application requires a high fidelity representation of the area of interest. Techniques are needed to generate the "missing" building structural features such as doors and windows in their correct dimensions, and spatial orientation with respect to buildings in the area and region of interest. Such techniques should incorporate an effective means of informing/alerting the trainee that specific elements in the scene are known only in a probabilistic sense with the degree of uncertainty assigned to the objects being conveyed to the trainee in a non-intrusive way.

Phase I: Explore techniques and develop a concept for generating and presenting "missing" visual data.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Commercial data bases for visual simulation of real-world objects and features.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-318 TITLE: Measurement of Cost Effectiveness as a Result of the Use of Training Devices/Simulators

CATEGORY: Basic Research

OBJECTIVE: To develop a model that will effectively assess the cost effectiveness of training devices/simulators.

DESCRIPTION: There is currently no established method for determining the effectiveness of training devices or determining how it's effectiveness relates to any ultimate cost savings to the Government. It is commonly recognized that training devices and simulators, such as the M1 Tank Driver Trainer and the Tank Gunnery Weapons Simulation System, reduce operational and support costs (eg, fuel, ammunition, and maintenance) for weapons systems and are therefore considered to be cost effective. However, the degree of their cost effectiveness is unclear. A cost effectiveness model is needed which will accurately and consistently determine the cost savings derivable from utilizing training devices/simulators as surrogates for the actual weapon system and/or firing of the weapons systems.

Phase I: Assess modelling approaches and develop a concept for assessing the cost effectiveness of training devices/simulators.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating the accuracy and consistency of the model.

Potential Commercial Market: A robust cost effectiveness model and methodology should be adaptable to non-DoD applications where there is a need to determine the cost effectiveness of training devices and simulators vice the use of actual equipment for training.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-319 TITLE: Application of Contemporary Psychological Research to Training Devices and Simulators

CATEGORY: Basic Research

OBJECTIVE: To develop more effective training devices and simulators through the application of contemporary psychological research.

DESCRIPTION: Training devices and simulators are already technically complex equipments that generally achieve their design/system objectives but the potential exist for making them more effective. Effective application of current research results in human cognition and performance which also exploits and complements advances in computer science and engineering, and instrumentation in the man-machine/training device environment could facilitate the desired improvements. Concepts in adaptive feedback and learning, techniques for augmenting short term memory, and effective methods of organizing and representing information so as to take advantage of "natural" or preferred modes of communication are considered to be especially relevant.

Phase I: Explore techniques and technologies and develop one or more concepts which could enhance the effectiveness of training devices and simulators.

Phase II: Design and implement one or more of the concepts from Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Public and private education; Computer based self help/study aids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-320 TITLE: Analytical Augmentation of Player Units in a Distributed Interactive Simulation (DIS) Environment

CATEGORY: Basic Research

OBJECTIVE: To provide effective mathematical surrogates for selected player units in the DIS environment.

DESCRIPTION: Future effective use of simulators in the DIS training environment could require large numbers of units of participating player units to be represented to achieve the desired training objectives. Realism is not an issue when all simulators are manned but this approach is considered to be impractical for large scale force-on-force training exercises in the DIS environment. A potential solution is the development of a capability to simulate and adaptively control the behavior of computer generated individual units and the tactically and doctrinally correct aggregations of these units inot hierarchically higher echelons of command. The goal is to develop a modeling methodology/technology that captures (1) relevant individual solider and unit behaviors, such as, communicating and exchanging information, maintaining and communicating and exchanging information, maintaining and changing formation, avoiding obstacles, making effective use of terrain for cover and concealment, and detecting, acquiring and engaging targets; and (2) relevant commander behaviors, at all appropriate command levels, such as the planning and execution of the command and control function (e.g. planning, executing plan, assessing, planning, etc.) in a dynamic and uncertain environment.

Phase I: Explore new techniques and approaches and develop a concept for realistic surrogates.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating the feasibility and effectiveness.

Potential Commercial Market: Entertainment and educational games, learning and design aids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-321 TITLE: Next Generation Dismounted Infantry Interactive Simulation Environment

CATEGORY: Basic Research

OBJECTIVE: To develop a dismounted infantry simulation module for use in a Distributed Interactive Simulation (DIS) environment.

DESCRIPTION: Current DIS training environments permit mechanized units to "fight" on a simulated battlefield. However, a key tactical element, the infantry, is not being adequately addressed in the training exercise. Mechanized units often operate in concert with infantry and must always be alert to the threat posed by enemy infantry. Similarly, individual infantry should get experience in working with mechanized units. Currently, the affects of the infantry on the manned DIS training participants are made through an extension of the semiautomated forces (SAFOR) model. However, this concept by itself does not permit the infantry's direct interactive participation in the training exercise. As an alternative, an infantry interactive module might incorporate SAFOR technology with a virtual reality interface thus ideally permitting the squad or platoon leader to be "totally-emersed" in this environment leading their "troops".

Phase I: Explore approaches and develop concepts for a dismounted infantry module in the DIS environment.

Phase II: Design and implement the concept form Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Personal entertainment video arcade simulators.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-322 TITLE: An Instrumentation and Threat Target Simulation Requirements Generation System

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-325 TITLE: Test and Analysis of Ada Language Programs

CATEGORY: Exploratory Development

OBJECTIVE: Develop a forerunner ADA Test/Analysis Tool that uses static and dynamic Software Testing and Analysis (STA) to curtail the spiraling cost of operating and supporting ADA software.

DESCRIPTION: As software complexity increases, current STA methods become inadequate. This leads to inefficient software development and the fielding of unreliable software. As a result, 70% of total life cycle costs for Ada software are spent on debugging software after fielding. New research at area universities has led to test and analysis methods that increase software reliability. These methods are ready for incorporation into a comprehensive STA tool. The development of an Ada specific tool of this type is needed to develop more efficient software thereby increasing reliability and reducing operational and support costs.

Phase I: The Phase I effort will consist of a feasibility study to investigate new theories and implementations as prospective components of an Ada specific STA tool. The result will be a detailed specification and a pilot implementation for a reasonable subset of Ada.

Phase II: The Phase II effort will consist of developing a fully functional Ada STA system. The system will be based on the components specified in Phase I. Experimental data gathered from Phase I will be used to revise and update the final system.

Potential Commercial Market: Due to Congressional and self-imposed commercial mandates, Ada implementation in the private sector has grown to make Ada one of the most highly utilized software languages in the United States. As the Ada market has grown, so has the market for Ada development tools. Presently, the large and growing commercial Ada market urgently needs an Ada development tool that reduces operational and support costs by development tool that reduces operational and support costs by improving software efficiency, and increasing reliability.

OSCR: Generic Cost Driver (GCD) #7 - Causes of Software Maintenance/Support Costs.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-329 TITLE: Data Base "Mining" through Machine Intelligent Learning Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop non-linear relationships among data elements that may define causes equipment failures and the increase in O&S cost burdens.

DESCRIPTION: Artificial intelligence researchers at government and privately sponsored laboratories have made significant progress in practical machine intelligent systems, capable of supervised and unsupervised learning. Some of these products and the expertise is being marketed commercially by small business start-ups. A practical demonstration and application is to use

these techniques to supplement conventional, statistical methods in finding cause and effort relationships in complex processes or machine failures.

Phase I: The contractor will research the state-of-the-art in both, hardware and software, to determine the most promising machine intelligent systems for unsupervised learning of databases. A final report will detail findings and a strategy to implement "data mining" techniques on large government databases. One Army database of interest is the Fielded Vehicle Equipment Performance Database System (FVEPDS).

Phase II: The contractor will continue the effort started in Phase I by implementing the planned strategy o" data bases identified by the government for field testing the most promising machine intelligent, learning methods. The test will be used to explore the performance and applicability of these techniques to find non-linear relationships among data elements that could suggest research projects, or changes in procedures, leading to reduced O&S cost burdens.

Potential Commercial Market: The same techniques could be used commercially to improve efficiencies in operations and reduce business risks. One application might explore the personality profiles of employees with job performance. This could lead to a more satisfied employees working at peak performance. Another application could explore the relationship between bank loand and business risk, finding those business characteristics that lead to a high payoff, low risk investment. A third application might explore the logistic problem of inventory control and optimization by exploring buying patterns and the changing preferences of consumers. A fourth application may be to monitor manufacturing processes and machines to determine factors that lead to out of tolerance conditions before they become critical. This could lead to higher quality product output and production cost savings.

OSCR: The goal will be to isolate high payoff, O & S cost reduction areas.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-348 TITLE: Image Processing Using Temporal Cellular Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: Produce a commercial charge coupled device (CCD) camera based on temporal cellular neural networks.

DESCRIPTION: The U.S. Army White Sands Missile Range has been following advanced in the field of neural networks for application in range instrumentation. Previously, these advanced had been confined to artificial neural networks, i.e.simulations of neural networks on conventional computers. Recently, advances have been made which may make it possible to field actual neural network technology for range instrumentation. Demonstration of this technology would require interfacing existing CCD sensors directly with temporal cellular neural networks and creating a CCD/neural network camera where signals can be processed by the neural network in a parallel and continuous manner.

Phase I: Research will be required to study and develop the design of such a camera. Because of the parallel nature of neural networks, an advanced design of how such a camera is interfaced to conventional processors and/or alternative neural network processors for further processing of the sensor data will have to be incorporated.

Phase II: Phase I design and development will lead to the implementation of a prototype version of the CCD/neural network camera. Testing of the camera will require novel techniques and use of available instrumentation.

Potential Commercial Market: True CCD/neural network cameras offer potential breakthroughs in commercial video technology in several areas: first, the standard NTSC signal would no longer be a time constraint for syncing to the video picture; second, the neural network eliminates the need for digitizing a video picture (a significant time savings); finally, neural networks would allow processing to be accomplished continuously so that pattern recognition algorithms could be processed in a fraction of the time it would take conventional processors.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-349 TITLE: Automated Foward Looking Infrared (FLIR) Resolution Measurement Using Fuzzy Logic & Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: Develop a new automated approach, using neural network technology, to objectively measure the Minimum Resolvable Temperature Difference (MRTD) and maximum resolution of Forward Looking Infrared (FLIR) systems.

DESCRIPTION: Automation of MRTD and maximum resolution measurement offers the advantages of measurement repeatability, reduced cost, and test time reduction. Currently, MRTD is performed in a time consuming, subjective manner, with several trained observers determining the final decision (given unlimited viewing time). Imaging infrared sensors that

require this laboratory measurement are expected to thrive as a primary technology well into the 21st century. The Redstone Technical Test Center (RTTC) has determined a need for development of a new automated approach for MRTD and resolution measurements. Although some "automated" MRTD methods currently exist, they do not actually model the human visual cognitive process involved with trained observer decision making. The method proposed should use a video frame storage and computer to replace the video display and the trained human operator which will remove operator subjectivity from the evaluation process. After digitization, the FLIR video signal will be processed through stages modeling the display-eye interface. A neural network will then analyze the processed image to determine the degree of resolution between the four bars of the target. The candidate neural network model to be investigated should use fuzzy logic with boundary and feature contour systems. This technique should offer the possibility of standardization between laboratories and test facilities.

Phase I: Complete conceptual design a development of a model for visual cognitive processing. Write computer code for image processing stages, boundary and feature contour models, as well as any other promising model(s). Conduct testing of actual FLIR data for repeatability and accuracy.

Phase II: Extension of the development effort into a deliverable system which will replace current subjective MRTD measurements using automated objective techniques via fuzzy logic and neural networks.

Potential Commercial Market: This project will extend the boundaries of both fuzzy logic and neural network technologies, resulting in unlimited commercial automation applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-353 TITLE: GPS-Driven Battlefield Visualization

CATEGORY: Exploratory Development

OBJECTIVE: Develop an effective capability to utilize real-time 3-dimensional coordinates as reported from a troop, vehicle, or airborne mounted dynamic GPS receiver to animate the viewpoint of battlefield visualization software running at a remote location.

DESCRIPTION: The significance of real-time troop/vehicle location reporting is critical in the AirLand Operations (ALO) doctrine, which supports smaller, dispersed forces fighting on an extended, non-linear battlefield. A real-time 3-D display of troop vehicle locations will facilitate the maneuvering and synchronization of dispersed forces by tactical commanders. GPS has already demonstrated its effectiveness in providing continuous, precise position determination required for the navigation of soldiers, tanks, ships and aircraft in Operation Desert Storm. A GPS-driven battlefield visualization capability will furnish real-time awareness of the location of troops, vehicles, and targets on the battlefield and a 3-D display of terrain constrained threats, providing an added combat multiplier for the Army.

Phase I: Study existing GPS-driven tracking and visualization technologies both within the community and in related fields to determine the feasibility and application of this technique. The study should culminate in a recommended design approach for a 3-dimensional battlefield simulation capability in which the viewpoint of the Army's visualization software is animated by the input of real-time, 3-dimensional GPS coordinates.

Phase II: Implement and demonstrate the design described above, to provide a system capable of delivering highly accurate, battlefield visualization software.

Potential Commercial Market: Phase III potential should be high. The use of GPS for tracking is already in use in the commercial trucking industry. Simulation in a growing industry, and the two together may have a commercial application in expanding opportunities for vehicle and aircraft traffic control, industrial monitoring, and entertainment.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-356 TITLE: Massively Parallel Graphics Workstation for Battlefield Visualization

CATEGORY: Exploratory Development

OBJECTIVE: Develop an effective approach to utilize massively parallel graphics workstations for battlefield visualization.

DESCRIPTION: The common bottleneck in real time computer graphics is the serial nature of computation, known as the Von Neuman Bottleneck. To resolve this bottleneck, the first "real" parallel computer was introduced about a decade ago. However, the high cost of these parallel machines and the lack of adequate algorithms for massively parallel processing has excluded its usage at the workstation level. The situation is changing. Size and cost are decreasing, and the availability of algorithms for general use on massively parallel machines is increasing. A need exists to investigate alternative graphics rendering schemes that take maximum advantage of massively parallel machines.

Phase I: Study the connectivity between conventional graphics rendering boards and a massively parallel machine's CPUs. Investigate efficient graphics rendering algorithms suitable for use on massively parallel machines with greater than 1000 processors. Document the feasibility of a massively parallel graphics workstation for battlefield visualization.

Phase II: The goal of this phase is to demonstrate the concept of massively parallel visualization using commercially available components and the algorithms and techniques detailed in phase I. The details of the work will depend largely upon the results of the previous phase.

Potential Commercial Market: The potential for commercial market is large. The fact that today's graphics applications are suffering mostly from the lack of computing power attests to it very well.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-357 TITLE: Cartographic Animation System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a geographically-based software animation system which is capable of displaying the movement of military operations over time.

DESCRIPTION: A cartographic animation system is needed to display the movement of military operations. Current animation systems lack the geographic referencing and temporal database links necessary to monitor the changing battlefield. The system should have the capability to display changes to point (ie. Military Units), line (ie. Forward Edge of Battle Area (FEBA)), and area features (ie. Area of Interest (AIO)) over time. The system should be geographically referenced and able to incorporate standard Defense Mapping Agency products for the map background. The system should also be able to extract data from a geographic information system for use in either the map background or for the changing features of the battlefield. Basic 'tweening' and 'morphing' capabilities for interpolating point, line, and area features between known positions are required. IN addition, the system should be capable of displaying environmental effects such as day/night illumination, snow, rain, fog, smoke, and other obscurants. Battlefield sounds will also be linked to the animation. Users should be able to develop custom symbols for display based on the attributes of the features in the geographic database. The system should allow flexible display of the movement of the military operations. Users should be able to control the rate of animation, move forward or backward in time, freeze the display, and zoom in on portions of the display. Users should also be able to annotate the animation using a capability similar to the 'chalkboards' on television instant replay and output the results to video tape.

Phase I: The contractor shall develop the concept for a cartographic animation system and demonstrate the basic capabilities to link to a geographic information system; animate dynamic point, line, and area features, incorporate environmental effects, and sound, and output the images to video tape.

Phase II: The contractor shall develop a prototype cartographic animation system. The system will have the capability to generate a new temporal database for mission planning or exploit an externally generated database for evaluating a previous operation. Full geographic referencing and use of Defense Mapping Agency products will be demonstrated, along with the capability to generate user-defined symbols.

Potential Commercial Market: Phase III potential should be high. A cartographic animation capability would be valuable for applications such as environmental monitoring, disaster planning and prevention, and transportation administration.

A-5 ADVANCED PROPULSION TECHNOLOGIES (I.E. MOBILITY AND LETHALITY)

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-076 TITLE: Critical Interior Ballistic Effects for Regenerative Liquid Propellant Guns

CATEGORY: Basic Research

OBJECTIVE: Develop an experimental capability to simulate the effects of high pressure/high frequency oscillations encountered by high-velocity projectiles and components during launch from the new generation of Army regenerative liquid propellant artillery/tank guns.

DESCRIPTION: This research concerns the development of a structural model to simulate the effects of high pressure (p up to 25ksi) and high frequency (f up to 50 Khz) oscillations encountered by projectiles/components during launch from liquid propellant (LP) guns. The model provides the scientific underpinning for the theoretical and experimental simulation of the LP effects. Using high velocity impact mitigation techniques coupled with mechanical dampers and filters, controlled high-frequency structural oscillations may be synthesized, spectrally shaped, and directed into the projectile/component structure at impact inside

gasgun devices (2" to 7" caliber). This capability is critically needed to validate the survivability and capability is critically needed to validate the survivability and performance of new concept/prototype projectiles, components and submunitions designed to operate with the new family of guns.

Phase I: Develop a Lumped-parameter model which combines structural-dynamic effects (geometry-dependent wave-propagation behavior, time-dependent loading rates, constitutive material properties) and crush mechanics/dynamics of impact mitigators (aluminum and steel honeycomb cylinders and cones), to describe the onset, dissipation, and decay of the oscillatory LP loading throughout the projectile/component structure as a function of time (t up to 50ms). Perform limited experimental validation on the 7" gasgun.

Phase II: Develop a 3D finite-element working model, using the considerations outlined for Phase I; validate the model on the 7" gasgun, and provide all mechanical devices used to synthesize, shape, and direct the structural oscillation into the test projectile. The model's objective is to predict experimental behavior within 20% of the measured dynamic response.

Potential Commercial Market: This new method will provide for the qualification of the commercial potential for electronic subsystems for communication, weather, and earth-observation satellites to space environments. The new method will provide for a substantial reduction in operating and support cost for LP projectiles & components. Single shot field launches could reduce from $20K per launch to less than $1K per launch.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-136 TITLE: Advanced High Temperature Strain Isolator Material System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a durable, low modulus material system having long life capability at temperatures of 2000 degrees F or higher.

DESCRIPTION: Intended use of material is as a thermal strain mismatch buffer between a high temperature structural ceramic and a conventional superalloy substrate. This "sandwich" structure is a candidate for application to advanced combustor liners, turbine seals, duct or end wall liners, or other static hot section components. Application of this material technology to future gas turbine engines will substantially reduce SFC (up to 3-4%), thereby reducing fuel costs.

Phase I: Identify low modulus material system; develop interface bonding techniques; select application for demonstration of system.

Phase II: Demonstrate low modulus strain isolator system in full scale component test incorporating ceramic outer layer and structural superalloy substrate.

Potential Commercial Market: Low modulus strain isolator material concept is applicable to static hot section components in commercial gas turbines as well as military.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-137 TITLE: Depleted Oxygen Gas Turbine Combustor Design

CATEGORY: Exploratory Development

OBJECTIVE: Develop a gas turbine combustor which can operate with large levels of dilution (recirculation).

DESCRIPTION: Advanced gas turbine cycles can involve combustion of air which has been diluted with combustion products. The dilution (recirculation) is introduced for NOx control or other benefits, and has an impact on combustor stability and performance. Gas turbine combustor performance using low levels of dilution has been investigated, but the allowable limits have not been established. It is anticipated that current gas turbine combustor design criteria will not be satisfactory for large dilution concentrations. Thus, novel combustor designs will be required for advanced gas turbine cycles. Advanced gas turbine cycles with novel combustor designs using dilution (recirculation) are expected to decrease gas turbine weight, volume, and fuel consumption, resulting in significant reductions in acquisition and life cycle costs.

Phase I: Demonstrate combustion stability of novel design concept(s) in a simple experiment. Measure basic performance parameters and sooting characteristics over a wide range of combustion product dilution. Recommend a candidate combustor configuration for Phase II development and testing.

Phase II: Develop, build and demonstrate the performance of a combustor with satisfactory stability and performance at high levels of combustion product dilution. Determine the limits of allowable dilution (recirculation).

Potential Commercial Market: This concept could be applied to all commercial gas turbine combustion systems.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-138 TITLE: Brush Seal Shaft Wear Resistant Coatings

CATEGORY: Exploratory Development

OBJECTIVE: Develop wear resistant coatings for use on shafts and other surfaces upon which brush seals rub.

DESCRIPTION: Since brush seals, in their application, must rub against a mating surface, tribological complements to the brush material must be utilized. Brushes are being investigated, developed and implemented in both metallic and non-metallic materials. Therefore, complementary rub surfaces must be developed for brush seals to realize their full potential. Significant savings are expected from the use of brush seals, due to their demonstrated SFC reductions (due to reduced leakage), and smaller performance degradation over the life of an engine.

Phase I: Identify potential tribological couples for representative metallic and non-metallic brushes. Identify and screen coating application methods. Screen coating materials for system demonstration.

Phase II: Demonstrate at least one metallic and one non-metallic brush rubbing against its tribological pair as a system at representative conditions.

Potential Commercial Market: Advanced brush seals are applicable in commercial as well as military gas turbines.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-139 TITLE: Electromotive Propulsion Concepts for Rotorcraft

CATEGORY: Exploratory Development

OBJECTIVE: Develop concepts at the main drive system or subsystem level (fuel control, lubrication, cooling, power control) supporting the ultimate development of electromotive propulsion concept for rotorcraft. Primary drive generators, motors, and controls, as well as all secondary and accessory systems inter-facing with the gas turbine prime mover are appropriate subjects.

DESCRIPTION: The electric drive system must be light weight, 0.3 lb/hp or less (comparable to advanced mechanical drives) and at least 95% efficient). Overall potential improvements in propulsion efficiency of the rotorcraft will result in substantial fuel savings over the operational lifetime. Compatible accessory and secondary systems are an essential part of the drive system and can instead be addressed in the program.

Phase I: Define overall drive system concept for two rotorcraft size classes (10,000-20,000 lb, and 60,000-80,000 lb); identify technology readiness for electric drive components comprising the system; or for associated subsystems; propose development plan required to address identified critical enabling technologies; assess overall system payoffs and risks.

Phase II: Execute high priority segments of development plan; demonstrate overall feasibility of achieving program objectives.

Potential Commercial Market: Results will be applicable to future commercial rotorcraft including conventional helicopters, tiltrotors, convertible drive systems, and fan-in-wing concepts. Retrofit to existing aircraft is also possible.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-140 TITLE: Fast Acting Valves for Turbomachinery Bleed Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a controllable valve to bleed or inject air into a turboshaft/turbojet engine compressor. This valve must operate and be controllable to frequencies high enough (150 Hz) to be used to locally influence the performance of a circumferential segment of a given compressor rotor.

DESCRIPTION: Recent research has indicated that the inception of a flow disruption in compressor rotors known as "rotating stall" can be delayed by locally affecting the flow conditions of the critical compressor stage rotor. The flow conditions might be locally modified using bleed behind or fluid (air) injection in front of the rotor. This would result in improved performance for the compression system. To accomplish this task, a valve is required that can cycle from full close to full open to full close at a speed of approximately 150 Hz. The valve would be sized to pass a maximum of approximately 1.65 ft(3)/sec of air at standard day conditions. Successful control of rotating stall inception will allow improved performance of turbomachinery which will reduce operating, replacement and repair costs by eliminating compressor surges which often result in hardware damage.

Phase I: Evaluate potential methods and innovative ideas to produce a valve that will meet these maximum requirements. Factors to be considered are: flexibility, size, cost, durability, and growth potential. Recommend a candidate approach to be pursued in phase II. Develop a methodology to describe the valve system fluid response to valve position.

Phase II: Demonstrate the approach by fabricating and testing a valve that meets the required specifications.

Potential Commercial Market: This concept could be applied to all commercial turbomachinery compressor systems.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-149 TITLE: Electrical Energy Recovery for Gas Turbine Engine Exhaust

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility and potential payoffs for using thermoelectric devices to recover waste heat in rotorcraft propulsion systems. Utilizing thermal energy available in engine exhaust systems results in an improved cycle efficiency and thus a lower specific fuel consumption (SFC). Therefore, the program addresses the Army's goal to reduce operating and support costs.

DESCRIPTION: Currently, the propulsion community is striving to double the capability of aircraft powerplants around the turn of the century. Advances in simple cycle (air standard Brayton cycle), however, may not be sufficient to achieve the ambitious cycle thermal efficiency required. Therefore, innovative cycle concepts need to be explored that offer advancements in engine SFC without compromising the horsepower-to-weight ratio of the simple cycle engine. Accordingly, it is desired to investigate/evaluate the feasibility of a lightweight, low packaging volume, bottoming cycle which utilizes thermoelectric/thermionic or other concepts to extract useful electrical energy from the exhaust of rotorcraft gas turbine engines.

Phase I: The Phase I effort shall include the selection of a baseline gas turbine engine and the identification of sufficient cycle parameters to describe the system. A feasibility analysis shall be conducted to determine the practicability of using thermoelectric/thermionic technology as a viable means to recover waste heat. This bottoming cycle concept shall be considered as a candidate to supply power to operate engine accessories, anti-ice systems, etc. The analysis, as a minimum, shall address materials, controls, related electronics, SFC versus weight, horsepower-to-weight ratio, packaging, exhaust temperature reduction, reliability, and manufacturing cost. The culmination of the Phase I effort shall be a preliminary design of the most viable electric bottoming cycle concept and a comparative performance summary to the baseline configuration.

Phase II: The Phase II effort shall include performing a detailed design, fabrication, and bench testing of the electric bottoming cycle.

Potential Commercial Market: Recovering waste heat from the engine exhaust results in an improved cycle efficiency and thus a lower SFC for commercial gas turbines. Any reduction in SFC is always of great interest to commercial aviation firms.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-156 TITLE: Surge Control for Turboshaft Engines

CATEGORY: Exploratory Development

OBJECTIVE: To design a system capable of avoiding an impending surge and smoothly recovering from rotating stall in a gas turbine engine.

DESCRIPTION: Gas turbine engines used in military applications require high performance and high reliability in order to ensure that the required missions can be completed effectively and safely. When a gas turbine engine experiences a compressor stall or surge, the given mission will be effected slightly or significantly. In cases of severe surge, the engine or drive train components can fail, causing loss of engine operation. When this happens on airborne platforms, the results can be catastrophic. Surge/stall has three causes: 1) engine deterioration, 2) aerodynamic distortions (especially at the air inlet), and 3) hot gas injection (from weapon firing). With modern technology, it may be possible to design new gas turbine engines, or modify existing ones so that occurrences of surge/stall are nearly eliminated. This can be done by implementing innovative control techniques using Digital Electronic Controls and fast temperature and pressure sensors, or by using methods that change the internal aerodynamics of the engine in order to actively avoid surge. Some of these methods are: movable plenum walls, air injection into the compressor, oscillating fuel flow, bleeding air from the compressor, actuating variable geometry etc. Using these techniques, it may be possible to reduce the required surge margin and operate near the surge region, thereby, running the engine at a more efficient speed.

Phase I: Perform a trade study that investigates new developments in the area of active surge control. Evaluate new methods by taking into account the maturity of the technology, developmental risk, ability to validate by using computer simulation, ability to engine test, and cost. Select specific method(s) to be engine tested in Phase II. Finally, perform an analysis that will quantify the effect that the most promising methods will have on engine weight, engine size, cost, specific fuel consumption (SFC), and power-to-weight ratio. Generate a formal report that includes the details and results of all of the activities performed in Phase I.

Phase II: Validate the method(s) selected in Phase I by performing extensive computer simulation. Fabricate and test a surge control system complete with all necessary software and hardware (in breadboard form). Generate a formal report that includes the details and results of all Phase II activities.

Potential Commercial Market: Manufacturers of gas turbine engines (especially engines used in fixed-wing and rotary-wing aircraft).

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-157 TITLE: High Velocity Combustors for Gas Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop improved diffuser/combustor aerodynamics that minimize diffusion and combustion pressure losses while maintaining proper combustor stability and turbine cooling backflow margin. Minimizing these losses results in an improved cycle efficiency and a lower engine specific fuel consumption (SFC). Therefore, the program addresses the Army's goal to reduce operating and support costs.

DESCRIPTION: As pressure ratios increase for modern engines, it becomes more difficult to design efficient diffusers which normally decelerate the compressor discharge flow from a Mach number of around 0.9 to around 0.1. If high velocity combustors could be designed to accept the diffuser exhaust at high Mach numbers, some of the pressure loss associated with the diffuser could be saved since the diffuser would not have to operate over as wide a range of pressures, thus giving a higher pressure recovery coefficient. The problem is that combustors are presently designed to operate at low reference velocities to maintain proper stability. To develop higher velocity combustors while maintaining stability will demand great attention to the air admission process. Stability is difficult to maintain at high altitudes and low power conditions where lean blowout is most likely to occur.

Phase I: Conduct preliminary design of combustors which will operate at entry Mach numbers up to 0.3. Different geometrics of the combustor's primary zone shall be considered along with various methods of fuel and air admission.

Phase II: Design, fabricate, rig test, and evaluate combustor for existing Army helicopter engine.

Potential Commercial Market: Improved diffuser/combustor aerodynamics will result in a better SFC for commercial gas turbine engines. Any reduction in SFC is always of great interest to commercial aviation firms.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-161 TITLE: Particle Trajectory Analysis for Turbine Engine Inlets

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced trajectory analysis techniques to improve the prediction of inlet particle separator sand removal efficiency and to expand the capability to model 3-D, non-axisymmetric flow paths.

DESCRIPTION: Current methods used in industry to model particle trajectories in inlet particle separators (IPS) have several limitations. Current trajectory analysis techniques are generally limited to 2-D axisymmetric ducts. Most of the modeling only uses a deterministic approach to model particle trajectories at the boundary conditions and to model bounce. The shortcomings of current particle trajectory analysis techniques result in the prediction of 100% efficiency of large particles and typically underpredict efficiencies for fine particles. One possible improvement would be to take a statistical approach to modeling bounce and to modeling particle trajectories at the inlet conditions. Expanding current codes to permit full 3-D modeling would permit the impasse of obstructions such as struts and scavenge vanes to be evaluation. A full 3-D code would also permit the modeling of engine nacelles and intake ducts, which would permit an assessment of IPS installation effects, and for non-axisymmetric IPS designs. Other potential improvements could include improved bounce modeling and to model particle interaction.

Phase I: Using a conventional fully 3-D flow analysis code, develop a 3-D trajectory analysis code capable of analyzing non-uniform particle flow boundary conditions and incorporating a probabilistic bounce model.

Phase II: Phase II work performed shall involve analysis of at least two previously tested IPS configurations to validate the code. Identify and implement enhancements to the code to improve the accuracy, speed, and user interface.

Potential Commercial Market: An advanced trajectory analysis code could be applicable to the design of inlet protection systems for commercial aircraft and ground vehicles, and for industrial air cleaners.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-162 TITLE: Adaptive Electric Anti-Icing for Turbine Engine Composite Inlets

CATEGORY: Exploratory Development

OBJECTIVE: To develop an adaptive electric anti-icing system for composite engine inlets including: the engine inlet nacelle, inlet protection system, and engine inlet housings.

DESCRIPTION: With the Army's interest in developing a more electric helicopter, industry is increasingly looking at electric anti-icing for inlet protection systems (IPS). Electric anti-icing offers reduced power utilization and lower weight over conventional methods using compressor bleed air. Moreover, the increasing use of composites in engine components is also driving industry to consider electric anti-icing due to the complex flow passages required for conventional anti-icing. Electric anti-icing composite materials can be accomplished in a variety of ways including: embedded wire, coated filament, and thermoelectric film. Unlike conventional anti-icing, electric anti-icing, would permit incorporation of adaptive features to better utilization of power, the ability to anti-ice localized icing patterns in the IPS associated with various flight conditions, and the ability to compensate for damaged sections.

Phase I: Develop and analyze the thermodynamic cycle and control logic for an adaptive anti-icing (AA/I) system. Fabricate a demonstration model of the system incorporating a composite specimen with electric anti-icing and an embedded thermocouple, and a breadboard control system. Conduct icing tests on the model to validate thermodynamic analysis and control logic.

Phase II: Fabricate several test specimens and conduct testing to determine the mechanical properties of the composite. Design and fabricate a prototype AA/I system for a current inlet component. Test the prototype to determine the performance of the system in a variety of icing conditions and in a simulated damaged configuration, and to validate the endurance of the system.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-163 TITLE: Braze Joining Ceramic Matrix Composite Components for Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop a joining method to attach ceramic matrix composite (CMC) components to the engine, where most components are metallic.

DESCRIPTION: The high temperature capability of CMC material will potentially allow for uncooled operation of hot section components in gas turbine engines. This will result in a reduction of the engine specific fuel consumption. Additionally, the high fracture toughness of the CMC will greatly enhance the component furability. A critical need for the commercialization of CMC components in turbine engines is the development of joining methods to attach these components to the engine, where most components are metallic. One promising joining method is brazing. Research is required in order to successfully apply this joining technology to ceramic composite components in gas turbine engines. The operating temperatures in CMC turbine engine components will require joining techniques which can withstand increasingly higher temperatures. The presence of fiber which may be attached by molten metals will also require very careful selection of the braze material. Additionally, the difference of thermal expansion between the CMC and the metal to which it will be joined will require careful management of the thermal gradients across the joint.

Phase I: Conduct a literature search to fully understand the current state of the art in brazing CMC composites to metals. Braze candidates will be selected based on the liquids temperature, expected strength, and an evaluation of the propensity of the molten braze to successfully wet the metal and the ceramic without attacking the fiber. Perform several brazing experiments to attach CMCs to metals consistent with those found in gas generator turbine engines. Complete an analysis and characterization of the resultant brazes. Mechanical and thermal testing will be done to evaluate the strength and ability to withstand thermal cycling for each braze combination. Recommend most promising braze for Phase II.

Phase II: Based on the recommendation from Phase I, perform additional experimentation and characterization, if necessary, to refine the braze metallurgy. Design an attachment scheme consistent with joining a CMC component to a

supporting metal structure. The design shall include a finite element analysis of the braze including the thermal and stress maps of the braze. Braze the CMC component to the metal supporting structure and test.

Potential Commercial Market: Joining technology sufficiently developed to allow incorporation of CMC component into an automotive or aircraft engine demonstration.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-165 TITLE: Ceramic Matrix Composite Component Improved Load Bearing for Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To improve the mechanical load bearing capability of ceramic matrix composite (CMC) 2-D fabric for future application in gas turbine engine components.

DESCRIPTION: The high temperature capability of CMC materials will potentially allow for uncooled operation of hot section gas turbine engine components resulting in significant reductions in specific fuel consumption. Additionally, the high fracture toughness of CMC greatly enhances the component durability. Currently, fabrication of mechanical load bearing fiber reinforced CMCs require the use of 3-D fabric preforms, which are a magnitude more expensive than 2-D preforming. As an alternative, the development of higher interlaminar shear strength would allow fabrication of load bearing CMC structures using cost effective 2-D fabric preforming techniques. Furthermore, composites with higher interlaminar shear strength would provide components with long-term durability.

Phase I: Evaluate a minimum of two technical approaches to increase the load carrying capability of 2-D fabric CMCs. Fabricate 4-6 CMC plates consistent with the approaches identified. Characterize the resulting composites by examining microstructure and performing a mechanical test matrix. Mechanical tests will include, as a minimum, interlaminar shear, coefficient of thermal expansion, and thermal conductivity.

Phase II: The improved material system developed in Phase I shall be tested in a turbine engine structural component. Additional fabrication, characterization, and mechanical testing of the plates utilizing the improved material system will be performed to provide sufficient test sample size for preliminary design values. Conduct an engine test of the CMC component to validate the design.

Potential Commercial Market: Will provide CMC technology sufficiently developed to allow incorporation of CMC components into aircraft engines cost effectively.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-173 TITLE: Turbine Engine Component Repair Concepts

CATEGORY: Exploratory Development

OBJECTIVE: To identify advanced concepts for the cost effective repair/refurbishment of high-dollar value components for small turbine engine systems in order to improve component and system life cycle costs. This program directly addresses the OSCR initiative generic cost driver number one "causes of electrical/mechanical replacement costs."

DESCRIPTION: Recently fielded and developmental turbine engine systems are utilizing components manufactured with material systems and fabrication processes for which there are no well defined repair procedures. Examples of these might be the utilization of single crystal turbine vanes and blades, and various other investment cast structural components. It is not unusual for these components to experience varying degrees of cracking and/or wear. If this damage progresses beyond allowable limits, component removal will be required. As it is well known, structures such as single crystal airfoils are very expensive to replace. For this reason it is very desirable to repair the components and return them to service. It will be the intent of this program to survey and identify potential processes which may be capable of providing the means to effectively repair or refurbish high-dollar value components.

Phase I: The Phase I effort shall consist of several activities. First, a thorough survey of the turbine engine industry, as well as Government/industry operated repair facilities, will be conducted to develop a definitive understanding of current and anticipated repair limitations and requirements for a matrix of high value components. Available data should be compiled which indicates actual and anticipated component failure rates, component damage/failure mechanisms, and actual or anticipated component costs. This data will be needed for cost benefit analysis and repair process identification. A second survey will be performed to identify those repair/refurbishment techniques and processes possessing the highest probability of providing a cost effective repair of high value components. It must be remembered that identified repair/refurbishment processes should not possess known limitations in their ability to return a component to usable condition. Repair processes must not degrade the

mechanical integrity or component functional characteristics. An assessment of anticipated repair cost(s) associated with the processes should be conducted and an initial estimate of component(s) life cycle cost improvements made. Following the survey activities, a detailed assessment of the most promising repair/refurbishment techniques should be conducted. This would be anticipated to include an assessment of repair practicality, and repair effectiveness with respect to durability, quality, and yield. Sub-scale trials of the identified repair/refurbishment processes should be conducted to allow for preliminary assessment of the mechanical properties of repaired structures and initial screening of processes and processing parameters.

Phase II: The Phase II effort will consist of the preliminary development of the detailed repair/refurbishment process specifications. Process parameter refinement requirements will be identified following a preliminary repairability/refurbishment demonstration. Mechanical property screening tests will be conducted to identify potential repair problems. Following preliminary repair trials, necessary process refinements shall be incorporated into each of the selected processes and full-scale component repairs will be demonstrated. The repaired component(s) will be subjected to mechanical and metallurgical evaluations to assess strength and durability characteristics.

Potential Commercial Market: Due to the extensive use of turboshaft and turboprop engines in the civil aviation community, the potential for exploitation of the repair technologies identified by this program is considered very good.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-174 TITLE: Auxiliary Bearings for Turbine Engine Magnetic Bearing Systems

CATEGORY: Exploratory Development

OBJECTIVE: Design and demonstrate auxiliary rolling element bearings to be used in conjunction with magnetic bearings for aircraft gas turbine engines.

DESCRIPTION: The use of magnetic bearings in aircraft gas turbine engines offers many potential advantages. These include the ability to operate at high temperatures and high speeds. The lubrication system could be eliminated, resulting in lower weight and reduced logistic support considerations. Magnetic bearings could be actively controlled to offer improved rotordynamic characteristics. The use of magnetic bearings requires auxiliary bearings to support the rotor while power to the magnetic bearings is off, if the magnetic bearing fails, and during transient conditions when the maneuver loads are too great for the magnetic bearing to handle. The engagement and disengagement of auxiliary rolling element bearings at full rotor speed will impose unique dynamic conditions on the bearings. The dynamic effects of these conditions must be considered in order to design durable, reliable auxiliary bearings.

Phase I: Perform a preliminary design of an angular contact ball bearing and cylindrical roller bearing for use as auxiliary bearings for a magnetic bearing system applicable to gas turbine engines. The bearings should be designed to operate at high speeds (3.0 to 3.5 million DN). An analysis shall be performed to investigate the dynamic effects of sudden engagement and disengagement at high speeds such as might occur during magnetic bearing failure or engagement due to maneuver loads or blade-out conditions. Results of the analysis shall be used to refine the bearing design.

Phase II: Design auxiliary bearings for use in a magnetic bearing rig test. Expand dynamic analysis to investigate rotordynamic effects due to changing bearing stiffness, changing rotor speed, and applied forces on the rotor system as a result of auxiliary bearing engagement. Fabricate auxiliary bearings. Perform rig testing of auxiliary bearings to investigate dynamic effects of sudden engagement and disengagement.

Potential Commercial Market: If magnetic bearings become feasible for aircraft gas turbine engine applications, the commercial market would be large. This program could also be applicable to industrial anplications of magnetic bearings.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-261 TITLE: Personal Computer Based, Graphical User Interface Configured, Generic Airbreathing Propulsion System Cycle Deck

CATEGORY: Exploratory Development

OBJECTIVE: Development of a P.C. based generic cycle deck for airbreathing propulsion systems that is configured through a graphical user interface.

DESCRIPTION: A generic airbreathing propulsion system thermodynamic cycle analysis model (cycle deck) is required. The cycle deck shall be utilized to predict the steady-state performance of various air-breathing propulsion cycles. The cycles of particular interest are: turbojet, turbofan, turboprop, ramjet, ducted rocket, and airturbo ramjet. However, the deck should not be limited to these cycles and should be able to accommodate the analysis of propulsion systems incorporating combinations

of critical features from those previously mentioned cycles. The model shall incorporate libraries of generic scaleable components. Components of particular interest are compressors (axial, centrifugal, mixed flow), combustors, gas generators, turbines (axial, radial, mixed flow), nozzles, exhaust ducts, afterburners, inlets, propellors, and ejectors. The cycle deck shall incorporate a graphical user interface that utilizes the Windows operating system and shall operate on an IBM compatible computer. The user shall configure a given propulsion cycle (graphically) by selecting and scaling a series of components from the generic libraries. This configuration process shall utilize a graphical interface that allows the user to interactively construct the particular cycle. Once a cycle is constructed, the graphical interface shall be utilized to execute on-design, and off-design performance predictions. The cycle deck shall easily (graphically) accommodate parametric variations of input variables such as critical component performance or flight conditions. The cycle deck shall have graphical outputs of various formats that permit ready analysis of parametric studies. The structures shall be modular in nature and allow for the continuous addition of component libraries and thermodynamic models.

Phase I: Under the Phase I effort, a detailed software structure shall be designed for the graphical user interface configured generic airbreathing propulsion system cycle deck. In addition, the executive program, with the graphical user interface, shall be developed, along with various airbreathing propulsion system component thermodynamic models. The ability to configure and analyze an airbreathing propulsion cycle (such as turbojet) shall be demonstrated. A complete demonstration of graphical interface is required. The software that is developed and any required computer software and hardware necessary for program execution shall be delivered to the Government for evaluation.

Phase II: Under the Phase II effort, the complete graphically configured generic cycle deck shall be developed. Numerous components libraries and component thermodynamic models shall be developed and integrated with the cycle deck. Complete documentation for operation and for the development and incorporation of new modules shall be produced. All software, required computer hardware, and documentation shall be delivered to the Government.

Potential Commercial Market: This item could be utilized by commercial gas turbine manufactures and by educational institutions.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-270 TITLE: Low Cost Generic Digital Thrust Controller for Tactical Missile Smart Propulsion Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop a Low-Cost Generic Digital Thrust Controller for tactical missile propulsion systems

DESCRIPTION: Traditionally, tactical missile systems have exclusively utilized solid rocket propulsion. However, the mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility that cannot be met with a solid rocket. On-demand thrust control will be required which will dictate the use of non-traditional propulsion systems such as: turbojet, ramjet (liquid or solid), air turbo ramjet (liquid or rocket), bi-propellant rocket, monopropellant rocket, hybrid rocket. All of these propulsion systems have a common functional element in that in order to achieve on-demand thrust variation, some form of control is required. Regardless of the specific propulsion cycle, the engine controller will require the same basic functionality - an external throttle command signal must be received by the controller, data must be acquired from control system sensors, and an output signal must be transmitted to a throttling device. Due to the functional commonality of the required control system for each of the throttleable propulsion systems, it is desirable to develop a generic engine controller that can readily be adapted to each specific application. The desired engine controller shall be digital and utilize a microprocessor as the central controlling element. The controller shall permit digital inputs to receive throttle commands and other external information. The controller shall have digital outputs to transmit information to the missile system and to command discrete events. A number of analog input channels shall be provided to receive sensor data. A number of analog output channels shall be provided to drive analog control devices. The controller shall be fully programmable to accommodate the specific logic requirements of the engine. The controller shall be modular in nature and shall be configured to accept input and output signal conditioning modules which are specific to the control requirements of the given engine. The generic controller shall be designed for a minimum unit production cost. Commercial technology shall be utilized to a maximum extent. The final control system is envisioned to consist of a generic control module combined with a number of more specific (but multi-application) input and output modules. The control system shall be a self-contained, stand-alone system requiring only throttle input commands. A unit production cost estimate shall be generated.

Phase I: Under the Phase I effort, a detailed design for the generic engine controller and interface modules shall be generated. The programmability and functionality of the central control unit shall be demonstrated either through a bread-board system or through a personal computer based system. This demonstration system shall be delivered to the Government for evaluation.

Phase II: Under the Phase II effort a production-ready configuration of the control unit and of the interface modules shall be designed, developed, fabricated, demonstrated, and delivered to the Government for evaluation.

Potential Commercial Market: This low cost controller could be utilized as a fuel control for lawn mowers and recreational vehicles.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-277 TITLE: Portable Static Test Facility for Small Expendable Turbojet Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop a portable static test facility for small expendable turbojet engines

DESCRIPTION: In recent years a number of small, low cost, expendable turbojet engines have been developed for missile applications. Due to the relatively small sizes (4.0 to 15.0 in diameter) and thrust levels (50 to 1000 lbf) of these engines, static test performance evaluations of these turbojets does not require (or justify) the use of a large-scale, dedicated engine test facility. The small size and simplicity of these engines make it feasible to perform static test evaluations in relatively confined locations with a minimum of supporting facilities. To permit the convenient and economical performance evaluation of these small turbojet engines, the development of a suitable small scale test facility is required. The test facility to be developed shall permit the static test evaluation of a wide range of small turbojet engines. The test facility shall be small in physical size and designed for installation and operation in relatively confined locations. The test facility shall be a self contained system that requires a minimum of external support facilities. The test facility shall be comprised of the following major subsystems: A. Test cell, B. Fuel storage/delivery, C. Instrumentation Interfaces, E. Control center, F. Personal computer based data acquisition system, G. Personal computer base engine control system, H Personal computer based data display system, and I. Signal conditioning. The test facility shall be modular and completely portable. All components shall be designed for movement and position with a fork lift. All components shall be transportable by a flat bed truck. The facility shall be designed for minimum emplacement and set-up time.

Phase I: Under the Phase I effort a preliminary design of the portable test facility shall be developed. To validate the feasibility of the design concept, the test cell component of the facility shall be designed, developed, fabricated, and delivered to the Government for evaluation.

Phase II: Under the Phase II effort the complete portable test facility shall be designed, developed, and delivered to the Government for evaluation.

Potential Commercial Market: This item could be utilized by commercial gas turbine manufacturers and educational institutions.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-279 TITLE: Windows Based Graphical User Interface for FORTRAN Based Propulsion System Analysis Codes

CATEGORY: Exploratory Development

OBJECTIVE: Development of a Windows Based Graphical User Interface (Input and Output) for Existing FORTRAN Based, Batch Executed Propulsion System Analysis Codes.

DESCRIPTION: Over the past thirty years, thousands of propulsion system engineering analysis computer codes have been developed. The vast majority of these codes were written in FORTRAN source code for execution in a batch mode on a mainframe computer. Predominantly, these codes utilize card image input sets with fixed field and/or namelist formats. In addition, output was typically configured in a tabular format that could be accommodated by a line printer. These codes represent irreplaceable investment in time expertise, and for the most part, are valuable and technically valid engineering tools. However, in light of the computational power of the current 80486 based IBM compatible personal computers (P.C.) and the convenient graphical user interface offered by the WINDOWS operating environment, the input/output interfaces and the mode of execution of these older codes are obviously antiquated. What is required is a methodology for the conversion of these existing propulsion system analysis codes for execution on a P.C. with utilization of a WINDOW based graphic input/output interface. A generic WINDOWS based user interface shall be developed. Through this interface the user shall graphically and conveniently specify the required input sets for a given analysis code. The interface shall also be used for execution of the codes and provide for convenient user configurable outputs in either graphical tabular format. The user interface shall be as general as is practical to allow incorporation with the widest possible range of analysis codes. The interface shall require virtually no

modifications to the FORTRAN source language of the existing codes. In addition convenient user modification and expansion of source code shall be readily accommodated. Integration of the interface with new FORTAN source code is also required. The interface shall be executed on commercially available IBM compatible P.C. hardware. The interface shall utilize commercial software development tools. All required hardware and software shall be delivered to the Government. The source code for all custom software shall also be delivered, along with all associated documentation.

Phase I: Under the Phase I effort, a detailed software structure for the graphical user interface shall be developed. The required commercial software, custom software, hardware, interface procedures, and operating procedures shall be specified in detail. A limited (but fully functional) version of the interfaces shall be demonstrated on an existing FORTRAN program. The desired program for the demonstration is the NASA Lewis Chemical Equilibrium Code (CEC) SP-273. This code can be obtained from NASA Lewis. All hardware and software required to execute the demonstration shall be delivered to the Government.

Phase II: Under the Phase II effort the complete graphical user interface shall be developed. Detailed code documentation. configuration procedures, and operating procedures shall be delivered to the Government. The utility of the interface shall be completely demonstrated through incorporation and utilization with several Government furnished FORTRAN analysis codes. All hardware, commercial software, custom software (with source code) required to develop, modify, configure, and execute the interface shall be delivered to the Government.

Potential Commercial Market: There is a huge commercial market. Any user of FORTRAN computer programs can utilize the user interface that is developed.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-284 TITLE: Airdrop Impact Decelerator Using Magnetic Technology

CATEGORY: Advanced Development

OBJECTIVE: To develop an Airdrop Impact Decelerator using Magnetic Technology.

DESCRIPTION: The application of magnetic technology for use as an airdrop impact decelerator has been proposed. Additional development and testing is required to effectively demonstrate this technology in an airdrop application. Magnetic technology offers tactical and logistical improvements over current technology (paper honeycomb). Combat effectiveness is improved through enhanced load survivability, reduced derigging times and elimination of paper honeycomb storage requirements. This technology may be applicable to cargo and personnel airdrop.

Phase I: The contractor will formulate and define a conceptual design for a magnetic technology based load decelerator. Perform calculations necessary to develop detailed performance specifications for load decelerator.

Phase II: The contractor will develop and test a full-size working prototype magnetic impact decelerator. Optimization of performance, materiel. weight and cost parameters shall be documented. The prototype shall demonstrate compatibility with existing airdrop components.

Potential Commercial Market: Commercial Aviation Industry

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-333 TITLE: Air Tank Recharging System

CATEGORY: Exploratory Development

OBJECTIVE: Provide an alternate system of starting a diesel engine.

DESCRIPTION: Engine-cranking system using compressed air are becoming commercially popular. If a vehicle has lost its air supply in the field, a recharging of its tank is required, usually from an assist vehicle, when available. There have been commercial installations where a hand powered pump was used to recharge a starting tank. It would also be possible to use a gas-generating cartridge fired into the tank; possibly even a 7.62 round with projectile removed.

Phase I: The contractor will research the energy requirement to successfully start various engines in the tactical fleet at -40 degrees F. He will develop two methods of charging the tank which are independent of the subject vehicle or an assist vehicle: one using a manual pump designed and/or modified to efficiently utilize soldier power, and one, if possible, to use one or more small arms rounds with projectile removed. In the latter safety ramifications, variability of results and deleterious effects of chemically induced corrosion on the starting system will be analyzed.

Phase II: Given a successful prototype of either or both systems, develop optimum designs which one producible and suitable for competitive solicitation.

Potential Commercial Market: Minor adaptation of teh subject system could provide a marketable kit for any air-started engine, particularly in cold climates.

OPERATING & SUPPORT COSTS: The hardware needed to recharge the air tank is low cost commercially available and/or stocked military items. An alternate starting method for air equipped vehicles is important if an when the air is depleted in the tank and no air source is immediately available to recharge the system.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-337 TITLE: Advanced Military Diesel Engine

CATEGORY: Exploratory Development

OBJECTIVE: the objective is to examine and develop technologies to increase fuel economy, increase power density with respect to volume and or weight, reduce specific heat rejection and provide RAM-D improvements for high output military diesel engines.

DESCRIPTION: Anticipated future high output engine operating conditions where cylinder heat loading will be greater than 4 HP per square inch (piston surface area), 4 cycle brake mean effective pressure exceeding 300 psia and brake specific heat rejection to coolant of 12 BTU per HP-Min or lower. Technology areas addressing these targets as well as that of reducing engine weight include: (1) high temperature tribology (Tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); (2) insulative componentry (Components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports. Novel monolithic and coating applications for these components will be considered); (3) fuel injection system/combustion enhancement (Technologies to be considered include ultra-high pressure injection or other combustion technologies enabling diesel combustion toward stoichiometric conditions without fuel economy degradation); (4) high efficiency broad range turbomachinery (Military diesels require compact, high efficiency, broad range, low inertia and tolerance to high exhaust pressure. Concepts to use a turboalternator as a compounding unit are being considered for electric drive applications); and (5) engine lightweight structural concepts (requirement are to provide dramatic weight reduction in diesel engine structure and componentry). Engine RAM-D goal of 1000-hour life expectancy shall be pursued in all designs or concepts proposed. Also concepts designs presented shall be consistent with army initiatives to reduce operating and support costs. Two generic cost drivers (1) causes of electrical/mechanical replacement costs and (2) causes of fuel/fuel distribution costs are directly applicable to this topic.

Phase I: The contractor shall research promising engine technologies and prove concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware initial bench type testing.

Phase II: Concepts shall be demonstrated in Phase II on a single or multicylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100-hours or more may be required.

Potential Commercial Market: Although commercial diesel engines ae generally operated at lower brake mean effective pressures (BMEP) than their military counterparts, the trend for commercial engines is now directed toward higher BMEPs for improved fuel economy and emissions reasons. THis trend has been observed in teh "Advanced Diesel Engine Program" being sponsored by teh Department of Energy. These advanced commercial diesel engines will require high temperature insulative and tribological componentry because of the higher operating temperatures encountered with the increasing BMEP levels. Insulating in-cylinder components and exhaust ports will provide an increase in exhaust energy which is beneficial when used in conjuction with exhaust energy recovery (turbocompond) devices. Turbocompound devices are an integral part of the design concept for these advanced engines. Power generated from these devices is returned to the engine crankcase which is key to the efficiency gainst to be made. It is therfore expected that the high temperature component and tribology technologies developed in this effort will have direct applicability to future advanced commercial diesel engines.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-339 TITLE: Innovative Heat Pipe Cooling System

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an innovative heat pipe cooling system for the M109 A6 Howitzer that is damage resistant, more thermodynamically effective than the present system and increasing the performance.

DESCRIPTION: The current M109 radiator is vulnerable to core damage causing the loss of engine coolant which immobilizes the vehicle. The cooling system is small and uses a high percent of the engine power to drive the fan. It would be desirable to have an innovative heat pipe cooling system with a 50 mile limp home capability that is also more effective than the current M109 cooling system while increasing the performance.

Phase I: In Phase I, the contractor would develop a concept for the innovative heat pipe cooling system and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for the M109 and provide the desired improvements. Current M109 radiators continuously cool the engine and transmission at full power, 14,400 BTU/MIN without exceeding 230 degrees F coolant temperature and 275 degrees F transmission oil temperature.

Phase II: In Phase II, the contractor shall fabricate and test a breadboard prototype of the innovative heat pipe cooling system. The following items shall be deliverable under this effort: design drawings, test report, final report and the vehicle worthy prototype.

Potential Commercial Market: Application can include such commercial vehicles as police cars, ambulances, fire trucks, armored trucks, or other vehicles exposed to rought field usage and where an added measure of reliability and serviceability will save lives. For example, this concept could provide a cooling system not susceptible to small arms fire as in a more exposed conventional radiator. THus heat pipe location flexibility results in eliminating potential engine failures due to coolant loss leakages, which also impacts on limiting a vehicle's performance and mobility. In conclusion, this technology could lead to a reduced operation and support (O&S) cost and improve the mission capability of any vehicle used in security or police type applications where radiator damage is at higher risk.

OSCR: This project has the potential to save lives, money, and equipment in a military conflict as well as help to assure successful completion of the intended mission.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-340 TITLE: Heat Exchanger Precleaner

CATEGORY: Exploratory Development

OBJECTIVE: Precleaner design concepts for military heat exchangers (e.g., engine coolant and oil, transmission oil, charge air, hydraulic oils) will be developed and demonstrated. Integration with the air cleaner scavenging system will be a primary objective.

DESCRIPTION: High fin density heat exchangers and heat exchanger locations contribute to fouling which result in high fluid temperatures. The design and installation of a precleaner ahead of the heat exchanger can remove most contaminants resulting in improved vehicle performance. Sizing of the precleaner to obtain high efficiency at air flows up to 10,000 cfm within confined space constraints is needed. Combat vehicle designs present unique challenges for packaging a precleaner within tight spaces. Integration of a precleaner heat exchanger scavenging system with the air cleaner scavenging system will be a target goal. Design goals include foul free heat exchanger scavenging system for the life of the vehicle. Primary emphasis will focus on new and present combat vehicles and tactical trucks.

Phase I: Heat exchanger precleaner integration development and design approach shall be investigated from a feasibility concept. This shall include a matrix trade-off and survey analysis to determine if any other approach concept is practical. This includes the investigation of a reverse flow fan. Bench breadboard tests will be conducted determing the best concept approach to eliminate fouling from dust and military fluids.

Phase II: The precleaner heat exchanger design concept shall be demonstrated in a mock-up combat vehicle propulsion system. Testing shall be accomplished in a lab to a duty cycle representative of cooling air flows. The demonstration will prove precleaner heat exchanger efficiency by demonstration of a floul free system when tested with dust and fluid contaminants. The design will incorporate were practical the engine's air cleaner scavenging system. Militarization and hardening of the heat exchanger components will also be verified and demonstrated.

Potential Commercial Market: Applications can be applied to off-highway commercial equipment which operates in dustry environments and results in heat exchanger clogging. This technology will improve reliability, ability and maintainability in both commercial and military applications resulting nin increased engine perofrmance and longer service life. In commercial markets this technology will also show a reduced maintenance burden through less servicing and replacement heat exchanger parts. In conclusion, commercial markets should realize lower operation and support (O&S) costs resulting in increased vehicle usage per year while maximizing a fleet or equipemnt owners profit margin.

OSCR: Heat exchanger clogging occurs in dusty environments causing engine overheating and increased vehicle down time. A clean radiator/heat exchanger will reduce maintenance costs through less servicing and spare parts. Cleaner heat exchangers will also allow a vehicle to operate at its maximum cooling capability resulting in improved vehicle fleet readiness.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-342 TITLE: Electric Drive Power Conditioning Units

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate power electronic packaging and cooling concepts which will significantly reduce the volume of the solid state rectifier and inverter modules used in electric drive configurations.

DESCRIPTION: The current technology rectifier and inverter modules require space claims which exceed the volume of the electric machinery they service. Additionally, the operating temperature of the switching devices used ir these modules require large cooling systems. The packaging methodology appears to be a part of the technology development which may offer acceptable solutions for future military and commercial vehicles.

Phase I: In Phase I the contractor would determine the limiting constraints of the available switching devices through lab evaluation. These limiting characteristics would include the operating temperature, the power ratings, and the power volumetric density (kw/m3). The contractor will then develop a solid state rectifier/inverter module packaging concept that will optimize the power density of both the module and its required cooling system. A breadboard prototype of the concept will be built and demonstrated.

Phase II: In this phase the contractor will design and build a rectifier/inverter module for 30 ton electric drive system. This power conditioning unit (PCU) must be suitable for installation in GFE electric dirve testbed which has a total power requirement of 1.1 MW.

Potential Commercial Market: Improved packaging of the power semiconductors will allow the power conditioning devices to operate at a higher temperatures and will significatnly reduce the size of the rectifier, inverter and their cooling systems. This is critical for both military and commercial vehicles full and hybrid electric whe . :imited spaces under the hood make it very difficult to package auxiliary cooling systems for the silicon devices. Improved ›wer electronic packaging will make it possible to use a common coolant for both engine and electric transmission and will reduce the size of the motor and genrator controllers approximately by a factor of 3.

OSCR: The knowledge obtained from this SBIR will be introduced in the current TARDEC electric drive programs for their merit in increasing the efficiency of the PCU and reducing the cooling load both of which will favorably affect the O&S cost.

A-6 POWER GENERATION, STORAGE AND CONDITIONING (I.E. DIRECTED ENERGY, MICROWAVE)

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-075 TITLE: Precision Triggered High Power Oil Dielectric Spark Gap Switches For Flash Gamma-ray And X-Ray Simulators

CATEGORY: Basic Research

OBJECTIVE: Develop triggered oil dielectric spark gap switches to improve the performance of Terawatt pulsed power nuclear weapons effects (NWE) simulators.

DESCRIPTION: Advances in oil dielectric spark gaps are sought to obtain reduced jitter, higher reproducibility, and lower inductance switching of multi-Terawatt, multi-megavolt NWE simulators. Oil switch configurations presently in use include V/N and rail edge-plane spark gaps that have been developed during the last 15-20 years. New applications such as SREMP testing require the development of a more precise triggering mechanism with emphasis on reproducibility of streamer initiation, number and spatial distribution of streamer channels, and characteristics that will reduce simulator risetime. The advanced oil dielectric spark gap should be scalable for use in small and large pulse power applications spanning the parameter space including: gap potential 100 kV to 12 MV; switch energy up to several megajoules; currents 10kA to > 1 MA; and electric fields-50 kV/cm to 300 kV/cm.

Phase I: Perform an experimental and theoretical investigation of the proposed concept. Design and perform a proof-of-concept experiment (POCE) which demonstrates the superior performance of the POCE device and determines the feasibility of scaling the switch concept for application as the output switches for the AURORA simulator.

Phase II: Further develop the switch concept for scaling to small and large pulse power systems. Design, construct, and test improved spark gaps as the output switches for the AURORA Blumlein pulse forming lines.

Potential Commercial Market: Advanced oil dielectric switches have several potential applications in the commercial sector. These applications make use of the high dielectric strength of transformer oil and the reduced flashover constraints that

make high pressure, gas spark gaps and plasma/gaseous electronic switches expensive and complicated to manufacture. The principal applications of the switching technology to be studied are in ultra-wideband impulse radars (UWB), accelerators for industrial processing, and as alternatives for superpower thyratrons. UWB radars can permit high resolution measurements at long range. G. Mesyats (Russian Academy of Science, Urals Div.) reported on such a radar system at the recent BEAMS '92 conference in Washington, DC (May 1992). Many such systems use a high pressure spark gap switch and achieve a 1-2ns risetime. However, oil switched systems in the US and elsewhere have obtained much faster risetime, but the triggerability, jitter, and reproducibility of such systems is not as good as gas dielectric switches. This is largely because very little basic R&D has been performed on oil switches i the last 15 years. Recent observations at AURORA (ARL in collaboration with Berkeley Research Associates and NIST) suggest that significant improvements are possible. Electron accelerators for industrial processing have long been in development. However, the commercially viable accelerators use conventional gaseous electronics switch tubes, e.g., hydrogen thyratrons, or spark gaps. Generally, such accelerators have low peak power and high average power. Applications such as pulsed lasers, super-power-electron beam welding, material modification, and radiation processing that might require high peak power have faced limitations because of opponent lifetime and reproducibility. Switches are a principal limitation. In this case, oil switches offer an alternative that has not received sufficient study. Finally, oil switches may offer a lower cost alternative to the super-power thyratrons that are being used for high power modulators that drive high power microwave sources. Such thyratrons cost 50-100 k$; oil dielectric spark gaps switches are expected to cost an order of magnitude less. The microwave systems have military application s that will soon make major changes in the way warfare is conducted. In addition, these microwave systems have applications similar to the industrial uses of electron accelerators, namely material processing and manufacturing.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-084 TITLE: Ferroelectric Capacitors for High Resolution - FPAs

CATEGORY: Exploratory Development

OBJECTIVE: Develop high dielectric permittivity thin films, such as barium titanate or lead zirconate-titanate (PZT) and high yield 3-dimensional capacitors to fabricate high capacitance per unit area capacitor structures for very high density read-out integrated circuits (ROICs), as required for infrared focal plane arrays (FPAs), to be used in both, non-radiation and radiation environments.

DESCRIPTION: General: ROICs for FPA read-out use capacitor storage and transimpedance amplifiers at each pixel node. As we move to longer wavelengths and much higher pixel densities, the number of quanta and hence the number of electrons to be stored increases and the physical area available for the capacitor shrinks. Therefore performance can only be maintained with the higher resolution by increasing the capacitance per unit area of the capacitors at each pixel node, compared with todays technology, using single level $Si0_2$ capacitors.

Phase I: Suitable ferroelectric thin film fabrication techniques should be developed, as well as their control and reproducibility.

Phase II: Developing a ferroelectric thin film capacitor technology for ROICs that has a capacitance per unit area of at least a factor of 4 improvement over today's single level $Si0_2$ capacitor.

Potential Commercial Market: Improved noise performance for state-of-the-art FPAs will have a positive impact on the development of radiation hardened and other SMART FPAs.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-085 TITLE: Very High Energy Primary and Rechargeable Lithium Batteries and Battery Chargers

CATEGORY: Exploratory Development

OBJECTIVE: Materials and technology for ambient temperature primary and rechargeable Li batteries. Power and energy density goals are: greater than 60 watts/kg and greater than 350watts/kg respectively for primaries (Option 1): greater than 40 watts/kg and greater than 200 watts/kg for rechargeables (Option 2). Development of a low cost battery charger for rapid recharge of 6, 12 and 24 volt lithium batteries (Option 3).

DESCRIPTION: General - Primary Batteries (Option 1) - Presently, energy densities upwards of 300 watt-hrs/kg can be obtained using $Li/SOCl_2$. A doubling of that energy density may be possible using solid electrolytes (bipolar construction) and/or more energetic cathode materials (e.g., fluorides, complexed halogen, atmospheric oxygen). Achievement of low temperature performance and good voltage regulation may be addressed from the systems point of view if necessary. Rechargeable Li

Batteries (Option 2) - Utilization of solid electrolytes with Li-insertion cathodes is the only approach yet identified. The performance goals stated above must be met over most of the ambient temperature range, -40° to 71C°. Battery chargers (option 3) - This program should concentrate on control methods for series - connected stacks of up to 4 cells with 5 Ah capacity.

Phase I: (Options 1 and 2) - identify one or more lithium couples with a theoretical energy density greater than approximately 1200 watt-hr/kg and compatible electrolytes which will allow maximum utilization of the intrinsic energy density. (Option 3) - Identify specific approaches and techniques for recharging both elemental and non-elemental Li batteries over a range of environmental conditions and demonstrate concepts using a battery stack of at least 2 cells in series.

Phase II: (Options 1 and 2) - Demonstrate advanced lithium battery technology by developing prototype cells or (better) bipolar batteries of up to 24V terminal voltage and over 10 A-hrs of capacity. (Option 3) - Demonstrate a prototype charger with the capability of recharging a 12 volt, 5 Ah battery in less than 3 hours.

Potential Commercial Market: Improved batteries and battery chargers will result in significant O&S cost reductions (OSCR) for many fielded C/E equipments and are urgently needed for future Soldier Systems and other future C3I applications.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-095 TITLE: Solid Electrolyte for Fuel Cells

CATEGORY: Basic Research

OBJECTIVE: Synthesize/fabricate a novel proton-conducting membrane for use in manportable fuel cells. The membrane is intended to enable lightweight fuel cells which will require minimum components for water management.

DESCRIPTION: General - Army manportable applications require fuel cells which are of minimum size and weight, minimum complexity, are robust and attitude-insensitive. At present, polymer electrolyte membrane technology appears best suited to such applications. However, the sulfonic-acid membranes presently available require water management in order to keep the membrane properly hydrated and to prevent "drowning" of the air electrode. An anhydrous proton-conducting membrane which could operate at temperatures between approximately 100-150 C° would be highly beneficial. The appropriate membrane should have good ionic conductivity and low permeability to hydrogen. The material must also lend itself to fabrication into sheets which are upwards of 100 CM^2 in area. Inorganic, polymeric and composite materials may be considered for this purpose.

Phase I: Phase I should include the evaluation of one or more classes of substances which are known proton-conductors or can be converted to that state. Evaluation may comprise measurements of conductivity, thermal stability and permeability to hydrogen. Phase I should result in the recommendation of one or more materials or composites for further study in Phase II.

Phase II: Phase II may include chemical modification and optimization of candidate materials selected in Phase I. It should result in samples of membrane and their evaluation for the properties specified above. The program may also include preparation of polymer-catalyst fuel cell laminates and their evaluation in small prototype H_2/air or $H_2/0_2$ fuel cells.

Potential Commercial Market: Manportable fuel cells are required for future Soldier Systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-098 TITLE: Components for Thin Film Bipolar Pulse Power Batteries

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate techniques to fabricate thin film bipolar cells for pulse power applications. The goal is the development of a 100 MJ battery with energy density of 100-200 kJ/kg and power density of 3-5 kW/kg in a volume of about 0.5 cubic meter.

DESCRIPTION: General - Thin film battery components are required to make high density/high power molten salt or solid state batteries for pulse power applications. Specifically, for electric gun applications, a 100 MJ battery is required with energy density of 140 kJ/kg, power density of 3kW/kg and a volume less than 1.0 cubic meter. The objectives can be achieved if thin film battery components such as the anode, cathode and separators can be successfully fabricated. This program should concentrate on the preparation of thin film battery components.

Phase I: Phase I should result in one or more approaches to the fabrication of thin film battery components. The thin films of high energy density cathodes such as Iron Disulfide, Cobalt Disulfide, Lithium Cobalt Oxide, etc., will be deposited on various substrated for use in bipolar batteries. Attempts will also be made to fabricate thin films of battery electrolyte separators such as the lithium ion conducting solid electrolytes lithium tetrachloro- aluminate, Lisicon etc., and composite porous

sintered ceramic separators incorporating molten salt electrolyte such as MgO, AlN, BN containing LiCl-KCl, LiCl-LiF-LiBN, etc. Finally the thin films of anode, separator/electrolyte and cathodes will be stacked together to make complete cells. Attempts will also be made to deposit layers of current collectors, cathodes electolyte/separator and anodes as multicell bipolar thin film batteries. Phase I will result in the selection of optimum conditions for fabrication of thin film battery components.

Phase II: In Phase II, a scale up of the technology developed in Phase I will be demonstrated as 10 MJ scalable modules. The approaches will be further refined so that a 100 MJ battery with required energy and power densities can be fabricated from thin film components.

Potential Commercial Market: Identified applications include electric gun, robotics, soldier integrated protective assembly, electric vehicles including non-military commercial applications.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-099 TITLE: Dielectric Materials for High Energy Density Capacitors

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel materials with high dielectric constant, high dielectric strength, high resistivity, and low dissipation factor for high energy/high power capacitors.

DESCRIPTION: Some future Army missions will require capacitors for high energy pulse power applications. The goal is a capacitor of a nominal rating of 10,000 volts and an energy density in the range of tens of kJ/kg. To achieve this goal, novel materials with properties aforementioned in the objective are required. The materials will include but not be limited to the following two categories: 1) Solid dielectric films of polymeric or inorganic nature. The ideal films should possess dielectric constants around 10; high dielectric strength; high insulation resistance; and low dissipation factors over a wide range of temperatures and frequencies. 2) Liquid dielectrics of organic, inorganic or polymeric nature. These liquids could be used as impregnants in capacitors to increase the maximum voltage of existing or new high energy dielectric films. Liquids with higher dielectric constants are our goal.

Phase I: Phase I should result in one or more candidate high energy dielectric/high strength films or liquids through new syntheses or structural modification of existing materials. Validity of the candidate materials should be demonstrated through preliminary dielectric tests including measurements of dielectric constant, dissipation factor, and dielectric strength.

Phase II: At least one of the candidate materials should be explored further through optimization in structure modification, purification or processing. The dielectric properties of the candidate materials should be evaluated. A scale-up production of the most promising material should be sought after. Complete small capacitors containing candidate materials will be constructed and evaluated.

Potential Commercial Market: High energy dielectric materials have direct applications and impact on the development of electric materials.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-102 TITLE: Array of High Power, Photon Triggered Ultra-wideband RF Radiators

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate phased-array techniques for constructive wave generation in the far-field, using high power, photon triggered ultra-wideband RF radiators.

DESCRIPTION: General - The free space transmission of a high peak power impulse produces a frequency spectrum that extends from several megahertz to several gigahertz. Utilization of this wide frequency spectrum results in a unique system applicable to the areas of impulse radar, remote sensing, communications, and weapons. The frequency spectrum of the impulse is widely spread, and therefore the energy allotted per frequency interval is small. In addition, the radiated power from a single ultra-wideband RF source is limited mainly due to the switch breakdown strength. The power limitation of the individual RF source can be overcome by operating arrays of these RF sources. A critical technological barrier is in the phased array technique, in which arrays of these radiators produce a constructive wavefront, so that an extremely high radiated power at the far field can be achieved.

Phase I: Phase I should result in mathematical formulations correlating the triggered time sequence of the radiating elements with a constructive wavefront formation in the far field. The operating sequence for the array of RF radiators involves charging and discharging the elements at controlled time sequences. The timing sequences of this array are controlled in such

a way that the radiated waves result in a constructive wave in the desired direction of space. A rigorous computer simulation is required for the follow-on proof-of-concept demonstration.

Phase II: In Phase II, the proof-of-concept field demonstration will be performed. Radiated waveforms from arrays of photon-triggered ultra-wideband RF generators, comprising a reasonable number of RF radiators, will be measured in the far-field. At least 5 radiators will make up an array. A wide range of experimental data will be collected, analyzed, and documented for further refinement and development.

Potential Commercial Market: Identified applications include Wide-Band Communications, Impulse Radars (for counterstealth, environmental studies, and air traffic control), Electronic Countermeasures, Mine Clearance, and High Power Microwave Weapons. The solid state based arrays of compact, high peak power, ultra-wideband RF radiators should impact all the aforementioned systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-143 TITLE: Magnetic Induction Launch-Coils for Plates or Plate-Like Structures

CATEGORY: Exploratory Development

OBJECTIVE: (1) To identify space-efficient magnetic-field configurations and concomitant containment structures with high mechanical strengths that can be used to launch plates and plate-arrays and (2) to identify and utilize innovative fabrication/manufacturing techniques to produce coils capable of withstanding very large mechanical stresses.

DESCRIPTION: The explosive launch of a plate or plate arrays is a very well-developed technology although it does have some disadvantages, e.g. self-hazards associated with explosives and logistics considerations. The electromagnetic launch of plates or plate arrays, in orientations both normal and perpendicular to the plane of the late, is an attractive alternative to explosive launch for various applications. The induction launch coils required, for the first phase of this effort, must withstand the stresses associated with accelerations which produce a momentum change of 200 kilogram-meters/sec over a distance of 0.15 meters or less.

Phase I: A successful phase I will identify one or more concepts for induction launch coils and provide a working brassboard coil based on one of these concepts which is capable of meeting the above specifications.

Phase II: A successful phase II will produce a scaled-up version of the coil produced in phase I.

Potential Commercial Market: Breakthrough in this technology has future applications in pulsed high-magnetic field environments and may impact in the design and fabrication in space, aerospace, ship and energy segments. Industrial application to high speed forging is a possible result of this effort.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-177 TITLE: Future Soldier System Power Source

CATEGORY: Exploratory Development

OBJECTIVE: Develop very high power density engines and electric generators with controls suitable for powering the future soldier systems.

DESCRIPTION: The future soldier is envisioned to require multiple enhancements and capabilities to improve fighting and survivability. Current DoD efforts are defining and projecting those capabilities. Multiple sensors, displays, and communication systems will allow greater mission effectiveness and a high degree of autonomy on the battlefield. Global deployment will require protective climate and chemical protective subsystems. One of the critical shortcomings has been identified as a lack of very high power density power sources to support the various subsystems that the individual soldier will be using. These range in power from 1 to 3 horsepower combined with a 50 to 100 watt generator with controls for basic systems to 5 to 10 horsepower source with hydraulic pump for supplying high pressure oil for an "augmented" externally assisted soldier.

Phase I: Preliminary analysis and design of the basic system and/or the hydraulic power system.

Phase II: Prototype systems suitable for concept demonstrations.

Potential Commercial Market: Lots of Commercial Applications, additionally, the systems will beintegrated into Advanced Technology Demonstrations in support of the Warrior's Edge. This effort addresses S&T Thrusts in sharping the warrior's edge and Star 21 focal values for methods and technology for integrated systems design.

OSCR: 1 and 4 Erosion/Wear and Fatigue (Mechanical Systems); Corrosion/Material Deterioration; Field Diagnostics/Prognostics; Reduce generator/battery size, improve efficiency of the Power Generator/Storage System, Provide alternate power sources; reduce power usage and improve battery systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-304 TITLE: High Energy Laser Gaussian Beam Generation Optical Development

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-335 TITLE: Infrared Lamp and Reflector

CATEGORY: Exploratory Development

OBJECTIVE: Development of an Infrared Lamp

DESCRIPTION: General: Development of an infrared lamp that will operate off a 24V DC power supply, will use less than 1200 watts, will generate infrared energy primarily in the 3-5 micron region, and can be focused into a 6 ft by 6 ft spot at approximately 6 feet. The effort sought in this solicitation is for new technological approaches to efficiently produce radiation in the 3-5 micron band. Basic: The desired attributes of an infrared lamp and reflector include: (1) capable of being integrated into a ground combat vehicle; (2) Useful durability and ruggedness for a ground combat vehicle; and (3) capable of operating at temperature extremes (0-50 degrees C).

Phase I: The contractor shall investigate, design hardware, and provide hardware for a proof of principle demonstration of an infrared source.

Phase II: The contractor shall fabricate and provide the hardware for a ground combat vehicle demonstration.

Potential Commercial Market: Medical light sources.

OPERATING & SUPPORT COSTS: This technology could significantly lower power demands on a ground combat vehicle and reduce electrical replacement costs. This technology could significantly reduce the weight of ground combat vehicles, resulting in more efficient fuel and ammunition usage.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-347 TITLE: Ultra-Wide Band Electromagnetic Source Development

This topic is CANCELLED.

A-7 BIOTECHNOLOGY

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-073 TITLE: Engineering Ribosomal Biosynthesis

CATEGORY: Basic Research

OBJECTIVE: Research to define scope of applicability for transfer RNA-mediated synthesis of novel materials.

DESCRIPTION: In the gene-directed biosynthesis of proteins, transfer RNA (tRNA) molecules serve to translate messenger RNA (mRNA) nucleotide sequence into proper sequence of the amino acids comprising the particular protein coded for by the original DNA sequence found in the gene. Carrying a specified amino acid at one end, and a particular mRNA nucleotide triplet binding site at the other, only the tRNA molecule, and not its attached amino acid, determines whether, and at which point on the growing polypeptide chain, the amino acid is incorporated. Recently, methods for adding engineered amino acids of desired structure into a tailor-made peptide polymer have been introduced. These techniques offer great promise in their potential for a low cost, energy efficient and environmentally benign method for manufacture of specialty polymers and possible novel matrices for composite structures, electronic/photonic materials, etc. The importance of this technology for competitive manufacturing capability in the commercial sector cannot be over emphasized, nor can its impact on DoD's "Technology for

Affordability" S&T thrust be over estimated. In keeping with Army's identification of "Genetically Engineered and Developed Materials" as a STAR 21 strategic advanced technology, basic research is needed to generate the information necessary for moving this technology from laboratory to demonstration scale for novel material synthesis.

Phase I: Generation of fundamental data in support of concept feasibility and merit of further investigation. Characterization of process.

Phase II: Demonstrate technology use in fabrication of protein polymer incorporating engineered amino acids with interesting material properties, including optimization of process, suitable for further development as manufacturing technology.

Potential Commercial Market: Commercial users of this technology would include a broad range of manufacturers of specialty polymeric materials, and perhaps even some classes of novel general-use polymers. Manufacturing process engineers would find this technology very attractive for transfer because of its high energy efficiency and low environmental costs.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-220 TITLE: Development of Non-Mammalian Antibody Expression Vectors

CATEGORY: Exploratory Development

OBJECTIVE: To explore the potential use of antibodies expressed in non-mammalian vectors, such as those formed between the fusion of hybridoma cell light-chain genes and E. coli, for use in immunodiagnostic assay systems. In addition, the potential of antibodies developed in eggs will also be explored.

DESCRIPTION: Recent advances in genetic engineering have allowed the development of antibody systems whereby light chain fragments from the antigen-binding region of antibodies can be expressed in non-mammalian cells. This has the potential to decrease the cost of production of antibodies and to develop a class of standard antibody preparations that may be subclass independent. The incorporation of antibodies into this type of vector system may also allow the cloning of reporter molecules, such as enzymes or fluorescent-proteins, adjacent to the antigen-conjugates to be made by genetic engineering techniques rather than through separate chemical reactions. The successful development of such a system should significantly decrease the cost of antibody reagents proposed for use in test kit and biosensor efforts. In another area, chickens' antibodies expressed in egg yolks have also been shown to be an effective means to produce large quantities of antibodies. The antibody is purified from the yolk of the egg, rather than by invasive techniques of the animal. This approach has the advantage of decreased non-specific activity, high yield, and low cost.

Phase I: Would consist of development of an antibody in a non-mammalian host with subsequent demonstration of the utility of the antibody in an immunoassay format.

Phase II: Would consist of the development of additional antibodies with demonstration of the utility of these materials on a biosensor system of interest to the Government.

Potential Commercial Market: The commercial market potential of these materials are high. Several efforts are already underway in the marketplace for this effort, both in diagnostic and therapeutic applications.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-243 TITLE: Fused Cholinergic Synaptosomes

CATEGORY: Exploratory Development

OBJECTIVE: Develop a cell-free system for studying the mechanism(s) of and interactions involved in cholinergic neurotransmitter release.

DESCRIPTION: Develop methodology for producing large fused cholinergic synaptosomes which are stable, consistent in their physiologic/biochemical composition and thus suitable for a variety of in vitro studies of neurotransmitter release mechanisms. The synaptosomes should be electrically excitable and contain the complete "machinery" necessary for calcium regulated, multiquantal release of acetylcholine. They would also be sufficiently large to allow for the introduction of chemical substances and voltage control by microelectrodes and patch pipettes. The ultimate goal is to co-culture these synaptosomes with skeletal muscle cells and attempt to overcome the botulinum toxin-induced block of neurotransmitter release by introducing putative antidotes. It is suggested that the synaptosomes be generated from torpedo electric organs, since these are a rich source of cholinergic nerve endings, and fused after purification with polyethylene glycol.

Phase I: Develop the methodology necessary to produce and characterize the synaptosomes.

Phase II: Produce research quantities of a stable, consistent product.

Potential Commercial Market: Studies of neurotransmitter release and cholinergic neuromuscular transmission are currently limited primarily to in vivo, ex vivo, or cell-culture systems, all exhibiting a certain inherent degree of variability. Large fused synaptosomes as described would allow for uniform, consistent cell-free or admixed cell/cell-free systems for studies of neurotransmitter release and neuromuscular transmission. Such a product would have wide applicability in the areas of Basic Research and drug development.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-246 TITLE: Hydrazine Air Monitor

CATEGORY: Engineering Development

OBJECTIVE: The ACGIH has recently proposed reducing the exposure levels for hydrazine and monomethyl hydrazine from 100 and 200 to 10 ppb, respectively. Monitoring instrumentation needs to be developed to measure these new exposure levels for hydrazine and monomethyl hydrazine.

DESCRIPTION: Our laboratory has recently developed continuous extraction technology for air toxics. Since analytical procedures already exist for determining low levels of hydrazine and monomethyl hydrazine, we would like to combine our extraction technology with the existing analytical procedures in order to develop a fuel vapor monitor to detect fuel at these new low levels.

Phase I: Evaluate currently available hydrazine detection capability for detection limits, precision, accuracy, selectivity among various hydrazine compounds, and the effect of possible interferences. Choose several of the methods which are amenable to automation and which could be used in conjunction with real-time extraction techniques for air toxics. Construct a bench top version of each of these extraction/detection systems and build a field prototype for laboratory and field evaluation. Complete laboratory testing of this first prototype.

Phase II: Field testing of the prototype will be conducted and completed. The prototype will be optimized for portability, field calibratability, low reagent consumption, and ease of operation. Ten prototypes will be delivered to the army for further field testing and evaluation.

Potential Commercial Market: The army, air force, and nasa will have need of such instrumentation to meet the proposed new acgih levels for these hydrazine compounds.

A-8 LIFE, MEDICAL AND BEHAVIORAL SCIENCES

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-070 TITLE: Executive-level Decision Skill Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: To develop an appropriate technology for assessing and accelerating the development of the basic cognitive skills underlying effective executive-level decision-making.

DESCRIPTION: A substantial amount of research now points to a relatively small number, perhaps as small as three, of critical cognitive processes which appear to underlie effective decision performance at the topmost levels of large-scale organizations. These are: mapping of the relevant decision environment (constructing a representation of the cause-and-effect relationships among the salient factors with which the position incumbent must deal); envisioning (constructing a communicable concept of an end state toward which complex activity can be directed); and long-range planning (constructing a path which will over a long time frame -- 15-25 years or more -- achieve a communicated end state). Coloring all these processes is a probable requirement for some degree of preference for innovation (proclivity to think outside bounded and well-defined solutions). Little is known about the development of these processes and their precursors.

Phase I: Phase I will require the development of a theoretical model that identifies and incorporates the three complex processes identified above, and the fundamental cognitive processes that underline them. A substantial amount of work has already been done toward this end. Phase I may therefore be considered a validation of that work. In Phase I, the existing conceptualization will be re-examined to confirm that it is consistent with the existing literature, and to determine if the literature identified developmental order effects.

Phase II: Phase II will require the design of "blueprints" for the construction of courseware designed to produce significant development of these complex cognitive processes. In addition, Phase II will require the completion of a demonstration module, with before and after measures, that successfully increases the performance level of students in these three

areas. The module will be applicable to Army Senior Service College use, but the blueprint will be generic to enable its application within non-military settings.

Potential Commercial Market: The theoretical model, the "blueprint," and the demonstration module will constitute a technology that can be applied broadly to improve executive development programs, both in large scale private sector firms and in the federal government. A major intended utility of this technology will be its generic applicability to a variety of different substantive content areas, and thus to a variety of different organizational contexts.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-071 TITLE: Component-Group Training Strategies

CATEGORY: Exploratory Development

OBJECTIVE: To estimate experimentally how component-group performance in situations requiring unit collective performance (e.g., mission planning) is influenced by amount and type of prior sub-group training.

DESCRIPTION: The dynamics of future conflicts will require timely and confident decision making, founded on effective training and mission rehearsal. The Army, however, is facing reduced training budgets. Training to achieve required collective (group) proficiency demands efficient, imaginative training strategies, especially for training command and control planning tasks potentially trained and rehearsed in synthetic environments. A key research issue is the question of the contribution of pre-training of sub-groups (e.g., S1-S4 elements or G1-G4 elements) before these elements are brought together for full-group mission training. Research is required to determine representative, and if possible, generalizable functions relating amount and type of sub-group training to group training performance. Four major sources of training variance are of concern: part-task vs. whole task training, skill acquisition vs. transfer-of-training, massed vs. distributed practice, and effects of prior knowledge. The literature on these areas should provide useful points of departure. Recent engagement simulation data have shown problems in performance where command and control staffs had not been trained as sub-groups before being brought together as a staff in realistic simulated exercises. While the focus could be on combat command and control planning and operations, surrogate tasks may be more suitable for this effort.

Phase I: The anticipated result of Phase I is a research plan and pilot data. The plan should include a focused and selective review of the literature. It should also include a preliminary model of sub-group functioning in a group context and provide a rationale for experimental task selection and research design. Pilot data should be sufficiently conclusive to warrant a full-scale study in Phase II.

Phase II: Based on the collection of more extensive data, this phase should result in a set of functions and conclusions relating amount and type of prior sub-group training to group training and performance. The data from this phase should be sufficiently conclusive to warrant refinement of the model so that it can be used for selection of the most cost-effective sub-group/group training strategy.

Potential Commercial Market: The results of this research can have wide applicability to training in security organizations such as law enforcement and fire fighting. The results will also apply to many group tasks in business, industry, and non DoD government agencies (e.g. emergency relief) where sub-groups, pre-trained in component tasks, are convened ad hoc, for special projects, or as permanent teams.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-072 TITLE: Measuring the Costs and Benefits of Army Service

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods and data sources for evaluating the economic and social costs and benefits of Army service.

DESCRIPTION: To provide a more objective basis for military personnel decisions such as determining appropriate compensation levels, the Army needs to develop data sources and method for measuring the economic and social costs and benefits of military service for individuals. These methods and measures must account for the long-term as well as the short-term costs and benefits. There is a particular need to evaluate these costs and benefits of Army service for women and minorities.

Phase I: The major task for Phase I is to identify relevant data sources and statistical methods and procedures for modeling the economic and social costs and benefits of Army service. A preliminary model or models would then be specified.

Phase II: In Phase II, a prototype model or models would be fully developed, articulated, and evaluated using data sources identified in Phase I.

Potential Commercial Market: The recent award of the Nobel Prize in Economics to Dr. Gary S. Becker at the University of Chicago, for extending "economic analysis to new areas of human behavior and relations" demonstrates the recognition of the importance of "behavioral economics". He effectively applied economic analysis to "settings where the economic forces don't seem to be most central". The proposed tools for modeling the economic and social costs of Army service will be used in a similar way in a military context. Their future extension to civilian applications can look at the long-term as well as the short-term economics effects of work group participation, especially for minorities.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-104 TITLE: Human Performance Issues in Automatic Target Recognition and Situation Awareness Displays

CATEGORY: Exploratory Development

OBJECTIVE: To experimentally investigate variables affecting human performance with situation awareness and automatic target recognition displays.

DESCRIPTION: For the foreseeable future Automatic Target Recognition Systems (ATR's) will include a man-in the decision-making loop. The man machine interface thus becomes a critical factor in determining how the system will perform. The program is aimed at investigating display parameters and human abilities and limitations (i.e., memory, keeping track performance, workload, stress) that impact system performance with both ATR and situation awareness displays.

Phase I: Conduct preliminary Human Factors experiments on target acquisition (recognition, identification, detection, keeping track performance, etc.) exploring variables such as (but not limited to) false alarm and miss rate, human confidence in information displayed, target priority and number, threat (real or perceived), cognitive load, etc.

Phase II: Pursue advanced experimental investigations of the parameters deemed to be the most important (i.e., having the most impact on system performance), with an eye towards generating man-machine interface design recommendations for both ATR systems and Situation Awareness displays.

Potential Commercial Market: Drug interdiction, search and rescue, reconnaissance, airline navigation.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-106 TITLE. Development of an Unmanned Ground Vehicle (UGV) Simulator

CATEGORY: Engineering Development

OBJECTIVE: Design and build a modular, interactive UGV simulator to evaluate operator machine interfaces and human factors design parameters to assist in the development and evaluation of remote UGV operations.

DESCRIPTION: The simulator will be modular in design, support graphic display(s) and incorporate a reconfigurable operator control unit to enable the Human Research and Engineering Directorate of the Army Research Laboratory to evaluate alternative control concepts and feedback issues for both simulated and actual unmanned vehicle operations. Many UGV operator control units are in existence and are in need of evaluation. In order for the simulator to be used to evaluate these units, it must interface to various control unit software and hardware designs and allow for reconfiguration to support software protocol interfaces and hardware integration. This capability will allow for comparative evaluation of alternative control units, user interfaces and control strategies to assess an UGV operator's ability to process data (i.e., video, graphic information, and audio) and execute mission tasks. The simulator must be able to control a software based emulated vehicle, to be developed under this effort, and an actual teleoperated vehicle. This simulator must be easily integrated to external communications equipment to allow teleoperation of an actual UGV. This simulator must also be equipped with tools to automatically collect and evaluate interactive operator/control station/vehicle responses to provide data for workload analysis and cognitive operator assessment. All operator stimuli and responses must be captured for analysis. To allow for complete evaluation of the UGV system and

maximize the usefulness of the simulator to the military user. the system must be interfacable to one of a number of GFE simulators of tactical ground combat to allow for evaluation under realistic combat conditions.

Phase I: Produce the hardware and software prototype of key components for the operator control unit interface to the simulator. Identify the technical issues and develop the approach to be used to completely develop the UGV simulator, to include identifying the means of integrating the tactical simulation, developing the emulated vehicle model, developing external communications interfaces, and developing the basic layout design concepts of the modular graphic simulator system.

Phase II: Deliver hardware and software of a complete system and use the resulting system to fully evaluate candidate UGV control interfaces.

Potential Commercial Market: The equipment and techniques developed under this effort could support driving simulators for automobile design and drivers education programs, and feed into aircraft simulators which have been in use for years and continue to be developed for the aircraft industry. Opportunities exist still in the video arcade game industry for driving games with enhanced displays and techniques for operator feedback. This effort will also find markets in the conduct of studies and evaluations to support military battlefield simulation models currently under development.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-166 TITLE: Adaptive Algorithms for Optimal Configuration of Cockpit Information

CATEGORY: Exploratory Development

OBJECTIVE: Develop software prototype for applying adaptive techniques, e.g. genetic algorithms, to cockpit configuration layout.

DESCRIPTION: New tools for cockpit information display and management will require novel approaches to cockpit design and evaluation. Genetic algorithms or similar adaptive techniques may prove to be a valuable approach to integrating such display and information management tools in future crew systems. The proven success of genetic algorithms at designing other complex mechanisms, such as semiconductor layouts and telecommunication network topologies, forms a reasonable basis for extending the methods to the configuration of cockpit information systems. Genetic algorithms are optimization techniques based on the theory of biological evolution, wherein such algorithms "evolve" a design to fit the specified criteria. It is expected that their ability to adapt without preconceptions to the data provided them would be beneficial to solving the problem of configuring cockpit information systems,a domain in which there is insufficient human expertise to carry out the design task well.

Phase I: Conduct an in-depth study of candidate crew system design issues appropriate to adaptive algorithms, isolating a canonical case for development. Produce interface specification with the Army/NASA Aircrew-Aircraft Integration (A3I) Man-Machine Integration Design and Analysis System (MIDAS) and develop stand-alone software demonstration of capabilities.

Phase II: Further integrate effort with MIDAS and extend approach to fully address constraints of practical crew station design problems. Demonstrate/test feasibility through comparison of adaptive algorithm recommendations with those produced by extant design practices.

Potential Commercial Market: Expertise gained from applying adaptive approaches to complex, multi-dimensional problems such as crew station design will greatly extend their potential commercial application. Genetic algorithms, like expert systems, fuzzy logic, or neural networks, are a general problem solving technique which can be applied to many domains. Their commercial viability is determined by their ability to help with practical problems. This project would be one of only a few applied examples in this emerging discipline and may open the door to very widespread use and commercialization.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-176 TITLE: Non-Lethal Weapons For Helicopter Use

CATEGORY: Exploratory Development

OBJECTIVE: Develop Non-lethal weapons suitable for firing/use from a helicopter.

DESCRIPTION: Currently U.S. helicopters are equipped solely with weapons which defeat the threat through explosive/catastrophic means. Many mission objectives could be achieved with weapons which temporarily or permanently disable equipment or crew without being lethal to the operators. The weapons may achieve mobility, forced landing or mission abort type "kills" against airborne and ground targets. They may achieve the "kill" through mechanical, electrical or optical disruption or failure and/or incapacitation of the enemy crew. These weapons must be suitable for use (launch or firing) from a helicopter platform and must be effective at ranges to 2km with greater than 2km desired.

Phase I: Develop the weapon-system concept for non-lethal weapons for helicopter use. Conduct laboratory demonstration of component technologies. Quantify estimated system performance. Produce final report.

Phase II: Develop a breadboard system for ground testing. Test against suitable target components and subsystems. Assess System Performance. Generate final report.

Potential Commercial Market: Effective Non-lethal weapons have significant commercial application for use by law enforcement agencies (Police, DEA, ATF, National Guard, etc.)

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-218 TITLE: Generic Biodetection

CATEGORY: Exploratory Development

OBJECTIVE: The project shall explore methods of using single or combined sensors to detect the presence of protein, bacterial, and viral samples and to identify these materials in a rapid and semi-quantitative manner.

DESCRIPTION: A need exists to rapidly and semi-quantitatively detect protein, bacterial, and viral samples above the environmental background. This suggests a multi-sensor approach whereby the sample is first immediately identified as being "different", and then subjected to successively more refined analyses. The ideal system would be automated and perform a complete sequence of analyses in five minutes. The end-of-analysis data would be the identity of the sample and some idea of how much.

Phase I: The offeror shall design and fabricate a laboratory prototype system which shall demonstrate the proof-of-principal of the general requirements on two model systems of interest to the Edgewood RDE Center.

Phase II: The offeror shall expand on the Phase I results by optimizing the detector system, testing it against at least two more bioagents of interest to the Edgewood RDE Center, and fabricating a breadboard for testing at Edgewood.

Potential Commercial Market: The offeror would be expected to apply the work outlined in this topic to the environmental area.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-219 TITLE: Biosampling

CATEGORY: Exploratory Development

OBJECTIVE: Investigate methods of bioaerosol sampling which use low power and still achieve high collection efficiencies in a two minute timeframe.

DESCRIPTION: A bioaerosol sampler is needed which can perform within the parameters stated in the project objective. Additionally, it must operate unattended for at least 24 hours. The bioparticles must be impacted into a liquid or onto a surface which releases the particles quickly into solution.

Phase I: A prototype sampler be built and tested to prove the feasibility of the concept. Although materials such as latex beads and ammonium fluorescein may be used for testout, the sampler must collect bacteria of choice at an efficiency which will provide 10,000 organisms in a 200 ul liquid aliquot after two minutes of sampling the aerosol.

Phase II: A phase II effort will involve a more in-depth analysis of the most promising avenues determined in Phase I. This phase shall include necessary design modifications, operational improvements, extensive and exhaustive testing, and final fabrication. An extremely important requirement is that the sampler must be able to be interfaced to a sensor. That is, it must have a solution flow capability. The project deliverable shall be a sampler meeting the requirements noted above.

Potential Commercial Market: The offeror would be expected to gain valuable experience and data in the portable biosampler area which could be applied to the environmental market.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-223 TITLE: Flow Cytometry

CATEGORY: Exploratory Development

OBJECTIVE: The project objective is to apply flow cytometric methods to biodetection (bacteria and viruses), and design and fabricate an instrument which meets CRDEC's detection needs. Light scattering and fluorescence approaches are to be used in the developed system.

DESCRIPTION: Flow cytometry is a method which has matured through the years to the point where it warrants attention as a potential biodetection system. A prototype flow cytometric based biosensor needs to be developed which uses both light scattering and fluorescence based methods to detect biomaterials. The system must produce qualitative results in two minutes and quantitative information in five minutes. The system must be configured to accept a fluid stream from an aerosol sampler.

Phase I: For the Phase I effort, the offeror may use a model bacteria and virus of his choice. This phase shall serve as a proof-of-concept in which a two minute assay of the model bacteria and virus shall be demonstrated and a portable flow cytometer designed.

Phase II: This effort shall use the results obtained in Phase I to fabricate, modify, and test a prototype flow cytometric system on at least four bioagents (vaccines and simulants) of interest to the Army. The basic chemistry, hardware, software, and analysis methods shall be optimized. Quantitation shall also be developed and optimized.

Potential Commercial Market: This work has potential applications in the environmental marketplace.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-224 TITLE: Less-Than-Lethal Immobilizing Chemicals

CATEGORY: Exploratory Development

OBJECTIVE: To suggest, acquire, evaluate and develop chemical immobilizing materials for application to various missions such as: rescue, embassy protection, anti-terrorism, barricade situations, domestic disturbances, and other law enforcement scenarios.

DESCRIPTION: Most recent Less-Than-Lethal (LTL) programs at the U.S. Army Edgewood Research, Development and Engineering Center have focused on the fentanyls as candidate compounds. Some of the fentanyls are widely used as injectable anesthetics. Others are being studied as wildlife and veterinary tranquilizers. Many of these compounds are well-characterized, rapid acting, very potent and reliable in their activity. However, for many LTL applications, they have safety ratios that are too low and durations of action that are too long. Ideally one needs a material that will act safely, virtually instantaneously and last for just a few minutes. Thus, candidate chemical immobilizers with improved safety ratios and shorter duration of action are needed.

Phase I: The feasibility phase of this program should result in the identification of one or more candidate LTL materials. In some situations, for example, close encounters, such as domestic disturbances, barroom brawls and stopped motorists or for rescue missions, materials should optimally be extremely fast-acting (few seconds), very safe and relatively short acting (few minutes). In other situations, such as barricades, speed of onset and duration of action may be less important, but safety will still be of paramount interest. Thus, it is desirable to identify more than one candidate material. It is preferable that a candidate material(s) should include the following steps: determination of the "state-of-the-art"; selection of candidates for preliminary evaluation; acquisition of test materials; and animal tests to indicate sufficient efficacy and safety to warrant further study.

Phase II: During this phase, further tests should be conducted to: establish effective doses and safety ratios sufficient for human estimates; establish times for onset and duration of effects; assess the effects of stress on effective dose and safety ratio; identify and conduct other toxicology tests necessary for human testing; and provide information for dissemination techniques and delivery devices.

Potential Commercial Market: Less-Than-Lethal chemicals that are safe and effective should have great commercial potential because they are likely to be adopted by many federal, state and local law enforcement agencies. In addition, there is a good potential market for similar products for use in wildlife management and veterinary medicine.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-226 TITLE: Chemiluminescence and Bioluminescence

CATEGORY: Exploratory Development

OBJECTIVE: To determine if the use of detectors other than photomultiplier tubes (i.e., charge coupled devices) will allow an acceptable limit of detection and reduction in size to develop a portable luminometer for detection of toxins, bacteria and viruses by chemiluminescent immunoassays. The potential of new or non-standard luminescent chemistries is acceptable if it will improve detection or work better in the offeror's luminometer.

DESCRIPTION: This project will be useful in determining whether or not bio/chemiluminescence has potential as a biological agent detector system. Bio/chemiluminescence immunoassays, as shown in the open literature, have superior limits of detection when compared to standard fluorescence immunoassays. The use of a Charge Coupled Device (CCD) based detector rather than a photomultiplier tube based detector would appear to offer the possibility of fabricating a fieldable portable biological agent detector system. Also, many immunoassay formats and bio/chemiluminescence chemistries have been developed which can be explored in a detector fabrication effort.

Phase I: The offeror shall develop and assemble a luminometer using a commercially available CCD. The detector should be capable of measuring glow, flash and enhanced flash reactions if possible. The luminometer shall be capable of presenting quantitative results. A determination of the sensitivity and detection limit using a standard chemiluminescent immunoassay will be required. (For example, CSA-1 antigen can be measured in less than 200 Salmonella typhimurium cells) A luminometer prototype is required at the end of this phase.

Phase II: The offeror shall fabricate a "breadboard" luminometer with a CCD sensor and the capability of being operated from an external IBM PC compatible computer. They shall develop an optimized bio/chemmiluminescent immunoassay of interest to the Army using the breadboard luminometer.

Potential Commercial Market: The successful completion of this effort would demonstrate the feasibility of developing a portable luminometer. A portable luminometer would allow competition in the areas, such as immunoassays, now using full size more expensive luminometers and fluorimeters and could be useful in the clinical and environmental areas.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-227 TITLE: Bifunctional and Catalytic Antibodies

CATEGORY: Exploratory Development

OBJECTIVE: The project objective is to investigate the potential of using chimeric and/or catalytic antibodies in immunodiagnostic assays.

DESCRIPTION: Current efforts with biosensors involve standard immunoassay techniques. The use of bifunctional and catalytic antibodies could serve to simplify the production of reagents to support these systems. For xample, a catalytic antibody could be developed which mimics the enzyme capable of transducing a signal in a biosensor system. This antibody could then be utilized in lieu of enzyme in a biosensor or could then be conjugated through chimeric techniques to an antibody fragment which has activity to a specific antigen. These approaches could have a positive impact on the logistical and stability requirements of proposed biosensor-based detector systems. Enzyme activities of interest include urease, phosphatase, peroxidase, beta-galactosidase, or acetylcholinesterase.

Phase I: Would consist of the development of a reagent for an antigen or enzyme activity of interest to the Army, the utility of which shall be demonstrated in an ELISA or equivalent system.

Phase II: Shall develop at least two more assays of interest to the Army on two dissimilar materials. Protocols for the synthesis/formation, purification, and storage of the antibodies shall be developed. The properties of the antibodies shall be fully characterized to include crossreactivity to the other assay materials and to their stability in solution for 24 hours at 37 degrees Celsius and in a lyophilized state at 60 degrees Celsius for one week. The demonstration of the reagents on a biosensor system of interest to the Army shall also be demonstrated.

Potential Commercial Market: The results of this work will offer improvements to assays used in the clinical diagnostic area as well as for environmental applications.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-234 TITLE: Passive Immunoprophylaxis And Immunotherapy Of Malaria

CATEGORY: Basic Research

OBJECTIVE: Produce, Characterize and develop functional igg human monoclonal antibodies for the treatment or prevention of malaria and the identification of protective epitopes for vaccine development.

DESCRIPTION: Malaria parasites are targets of humoral immune responses at several points in their lifecycle, and these targets form the basis of active vaccine development. An alternative approach is to screen or stimulate in vitro human immune lymphocytes for the production of human monoclonal antibodies (humabs). Igg class humabs have preferred pharmokinetics but table igg clones have been notoriously difficult to produce. Proposals are requested that 1) identify new methods of identifying and/or producing igg humabs against malaria 2) demonstrate their activities using in vitro functional assays and 3) prepare selected humabs for phase I clinical trials 4) demonstrate methods by which such humabs may further be used to select or map epitopes for the development of active vaccines.

Phase I: Demonstrate methods of producing one or more stable functional igg human monoclonal antibodies against asexual erythrocytic stage plasmodium falciparum parasites.

Phase II: Produce and characterize one or more humabs in sufficient quantities to permit feasibility demonstration of passive transfer studies in animal models.

Potential Commercial Market: drug companies, who, military, travelers.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-235 TITLE: Systems To Automate The Deglycerolization Of Thawed Frozen Human Blood.

CATEGORY: Basic Research

OBJECTIVE: To remove the glycerin-cryopreservative from human red blood cells in a sterile, rapid guide (<30 min), labor non-intensive manner.

DESCRIPTION: A unit of frozen-thawed red cells contains about 200ml of red cells and 200ml of cryopreservative containing about 100-150g of glycerine. The glycerine must be removed from the red cells by a sterile procedure which does not harm the cells, and is quick, and low in labor requirements. Final equipment should be less than 8 cubic feet in size and have expendable components competitively priced with the currently-approved centrifugal techniques. Device should require minimal operator interaction and minimize maintenance.

Phase I: Show feasibility of a closed, automatable techniques, perhaps using membrane technology, to safely separate red cells from glycerin solution. Saline wash solutions should be used.

Phase II: Develop a prototype and show its capabilities on units of frozen thawed blood. Performance/costs must be superior to current centrifugal technology.

Potential Commercial Market: Several million units of red cells per year could be processed in this manner.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-236 TITLE: Directed Biosynthesis Or Isolation Of Soluble Porcine Lipopolysaccharide Receptors

CATEGORY: Basic Research

OBJECTIVE: To develop soluble lipopolysaccharide (lps) receptor sites, suitable for injection into microswine, capable of binding endogenous lipopolysaccharide released from gut flora in response to reductions in splanchnic blood flow.

DESCRIPTION: We have recently hypothesized that the pathophysiology of environmental injury or illness may result in part from the release of endogenous lps when blood flow is diverted from the splanchnic bed in response to exposure to severe heat or cold. Exogenously administered soluble lps receptors would competitively inhibit lps binding to its endogenous receptors on macrophages, thus interfering with the cascade of events leading to endotoxin morbidity or mortality. The soluble lps receptors should be developed from the microswine to assure compatibility with the animal model used for efficacy testing.

Phase I: Synthesize, isolate, or otherwise develop soluble lipopolysaccharide receptors suitable for injection into the vasculature of the microswine model.

Phase II: Demonstrate the efficacy of injected lps receptors as either immunoprophylaxis or immunotherapy against endotoxemia resulting from heat and cold injury in microswine.

Potential Commercial Market: Companies seeking therapeutic procedures for toxic shock or other endotoxemic pathology.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-237 TITLE: Neutralizing Monoclonal Antibodies Against Biological Toxins

CATEGORY: Basic Research

OBJECTIVE: Provide neutralizing monoclonal antibodies for specific toxins and threat agents.

DESCRIPTION: Using traditional approached or novel techniques of in vitro stimulation of human spleen or peripheral cells or recombinant conversions of mouse monoclonals, produce humanized neutralizing monoclonal antibodies with specificity for important toxins and threat agents. Antibodies for specific toxins such as: Bacterial (botulinum, staphylococcal enterotoxins, blue-green algal toxins (microcystin), dinoflagellate toxins (saxitoxin), vertebrate toxins (tetrodotoxin) protein synthesis inhibiting plant toxins (ricin), protein and peptide toxins of other biological origin (including pre- and postsynaptic neurotoxins, and membrane active substances), and other bacterial toxins such as clostridium prefringens toxin, are of particular interest. Physiologically active compounds of biological origin are also of interest as are anthrax, tularemia, q-fever.

Phase I: Generate antibodies and demonstrate neutralizing specificity in a model system.

Phase II: Produce research quantities of the specific humanized monoclonal antibodies.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regimen exists. Neutralizing monoclonal antibodies against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-238 TITLE: Development Of A Reactive Topical Skin Protectant (RTSP)

CATEGORY: Exploratory Development

OBJECTIVE: To explore, identify and develop materials and methods of incorporating reactive materials that will neutralize chemical warfare agents (cwas) into a protective barrier that can be applied to the skin of a soldier to protect him from the cutaneous hazards of a noxious chemical environment.

DESCRIPTION: There is currently a requirement to develop and to field a rtsp to serve as a reactive barrier when applied to skin of soldiers that will render ineffective the dermal threat of chemical warfare agents by decreasing skin exposure and by neutralizing the agent. Desirable characteristics of this skin applied product include efficacy against all known dermal cwa threats, safe and nonirritating, stable, and compatible with other soldier use and chemical agent detection systems. Strategies that have been identified to accomplish this task include incorporation of the following materials into an ointment or other medium that already has barrier qualities: Reactive chemicals, reactive assemblages of molecules, reactive resins, enzymes, antibodies, catalytic antibodies. Successful proposals must possess a viable concept and an evaluation plan demonstrating a logical sequence of steps to identify, and incorporate and test the reactive materials to prepare the final product.

Phase I: Survey, test and establish the reactive and/or adsorptive species to be used in the rtsp. Characteristics such as reactivity (kinetics) stability, skin toxicity, availability, cost and compatibility with the protective barrier must be considered. Concurrently, a protective barrier that is compatible with reactive species and also with skin use must be developed. Finally, reactivity and stability of the combined protective barrier and reactive species must be demonstrated.

Phase II: Establish in vitro efficacy of proposed rtsp against cwa stimulants using testing procedures already established by the U.S. Army.

Potential Commercial Market: Industries currently exist in which workers are exposed to toxic materials e.G. Pesticides, herbicides, as well as other chemicals that represent health hazards. Use of a rtsp would provide these workers with protection against these noxious chemicals.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-239 TITLE: Develop Methods For In Vivo Delivery Of Dengue Proteins To The Cytoplasm Of Cells For Antigen Processing and Presentation

CATEGORY: Basic Research

OBJECTIVE: The objective of this proposal is to provide a method for stimulating cd8 lymphocytes in a recombinant protein vaccine. The method or product must be potentially usable in a human vaccine.

DESCRIPTION: The method with the most potential as a vaccine engineering tool for stimulation of cd8 lymphocytes is acid labile liposomes. There has been some method development and patents obtained concerning production of acid labile liposomes for vaccine production. This project would focus on the adaptation of this proven method to in vivo delivery of dengue proteins. Acid labile liposomes are stabilized by serum proteins if not properly engineered. Recent publications indicate that this problem has been largely overcome and that the major focus of the project would be adaptation of the technology to dengue proteins.

Phase I: The first phase would be continued adaptation of the methodology in in vivo conditions. Completion of this phase of development would be essential for progression to the next phase.

Phase II: Dengue proteins supplied by the department of viral diseases, wrair would be packaged by the small business and returned to wrair for assessment of the immunogenicity of the packaged product.

Potential Commercial Market: Dengue vaccines, other vaccines of interest to the dod.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-240 TITLE: Tissue Adhesives For Battlefield Hemorrhage Control

CATEGORY: Basic Research

OBJECTIVE: Develop a fibrin-based tissue adhesive that can be used to control life or limb-threatening hemorrhage on the battlefield (pre-hospital setting).

DESCRIPTION: Hemorrhage is the cause of many battlefield deaths and increases the morbidity of surviving casualties. An effective method for controlling hemorrhage in forward treatment elements (pre-hospital, non-physician providers) would greatly impact on combat mortality rates and decrease logistical requirements for combat casualty care. Fibrin tissue adhesives have been widely used in surgery to control surgical bleeding, increase the adherence of skin grafts and nerve anastomoses, and to increase tissue adhesion in eye and ear surgery. No products have been developed that could be used to control arterial and venous hemorrhage in a first aid setting. Furthermore, the opportunity exists for adding growth factors and anti-microbials to fibrin adhesives, allowing definitive closure and accelerated healing of soft tissue injuries that would otherwise require surgical treatment (e.G., Suturing).

Phase I: Identify products and methods for developing a fibrin-based tissue adhesive that can be used for pre-hospital control of hemorrhage from penetrating trauma.

Phase II: Develop durable low weight delivery systems for fibrin adhesives that can be used by combat medics under austere conditions with minimal preparation.

Potential Commercial Market: Directly applicable to controlling hemorrhage by paramedics and emts in the pre-hospital setting.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-241 TITLE: Medical Vision Enhancement Prosthesis For Military Laser Retinal Injury

CATEGORY: Basic Research

OBJECTIVE: To develop a rationale for and an optical prosthesis for military laser retinal injury.

DESCRIPTION: Laser/photic retinal injury alters color vision mechanisms and affects spatial vision depending on the size and retinal location of the lesions. The potential exists to improve color vision and thereby enhance color discrimination (e.G. Detection of camouflaged targets) by modification of the spectral input to the eye. Spatial vision changes result from localized retinal injury. Small rapid shifts in the retinal image location produced by optical or electro-optical techniques which rapidly move the image plane between normal and damaged retinal sites could potentially improve visual performance of the inured eye.

Thus, the impact of a partial or absolute scotoma would be minimized and the quality of life of a patient injured by laser radiation would be enhanced.

Phase I: Develop and articulate the rationale for vision enhancement prosthesis and initiate device concept analysis.

Phase II: Fabricate prototype devices and begin testing. Provide five prototypes to the usamrdc for further evaluation.

Potential Commercial Market: Potentially applicable to laser and other blinding retinal diseases.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-242 TITLE: Development Of Field Oriented, Nucleic Acid Amplification Methods For Rapid Identification Of Biological Threat Agents

CATEGORY: Basic Research

OBJECTIVE: To develop a system for identifying militarily relevant agents of disease, such as anthrax, botulinum, etc. Under possible field environments and to evaluate such a system against relevant clinical specimens.

DESCRIPTION: Gene amplification methods such as polymerase chain reaction have proven to be a tremendously powerful, rapid and sensitive tool for identification of pathogens. The techniques have found application in clinical diagnostic settings, but are currently too unwieldy for field-expedient use. A system is required to diagnose casualties of biowarfare agent exposure, which simply and efficiently processes appropriate tissues for nucleic acid extraction, amplification and post-amplification detection of products. Additionally, this system should possess little or no risk for cross-over contamination, have high stability, and be relatively user-friendly.

Phase I: Design a field-expedient system that provides specific nucleic acid amplification and post-amplification detection.

Phase II: Evaluate system against other diagnostic methods using clinically relevant specimens and scale-up for production.

Potential Commercial Market: Physician's offices, hospital laboratories.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-244 TITLE: Development Of Diagnostic Probes For The Detection And Surveillance Of Drug Resistant Parasitic Infections

CATEGORY: Exploratory Development

OBJECTIVE: To develop probe(s) that will provide rapid field identification of drug resistant plasmodium falciparum malaria and leishmania species.

DESCRIPTION: The phenomenon of resistance to drugs by prokaryotic and eukaryotic pathogens is a matter of great practical concern. The prevalence of multidrug resistant strains of p. Falciparum and the unresponsiveness of cutaneous and visceral leishmaniasis to antimonial therapy is a serious clinical problem that represents an important threat to the complete direct identification of drug-resistant parasites in easily obtainable patient samples. The probes would call for a single reading of results by semi-skilled technical staff. The probes should be specific, sensitive and inexpensive. The quantities required for in vitro and field testing of each probe submitted is about 100 and 1000 reactions, respectively.

Phase I: Submission of potential probe(s) in the appropriate quantity and quality for in vitro testing against reference drug resistant and sensitive parent clones of the parasites.

Phase II: Submission of additional quantities of specific probe(s) for field testing and evaluation.

Potential Commercial Market: Malaria is a world wide health problem. Rapid, specific, sensitive test for malaria would have broad market application.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-245 TITLE: Systems To Detect Bacterial Contamination Of Banked Blood In A Rapid, Non-invasive, Low Technology Manner

CATEGORY: Basic Research

OBJECTIVE: To determine if banked blood is contaminated with bacteria by a rapid (1 hour?) Method that does not require entering the blood bag, or the use of high tech analytical instruments.

DESCRIPTION: To develop a device to detect bacteria in bags of stored blood without contaminating the blood, removing the blood from the bag, or the usual long delays and equipment requirements of culturing techniques. Perhaps a disposable sensor-type device which could be manufactured into the bag system, or a small portable "box" into which the blood bag could be placed for a few minutes to "sense" the presence of bacterial in the bag.

Phase I: Develop bacterial sensor technology which works in presence of whole blood.

Phase II: Produce prototype that works on banked blood in plastic blood bags.

Potential Commercial Market: 12 million units of blood in u.S. Each year.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-247 TITLE: Identification And Diagnosis Of Toxin Exposure And Infectious Diseases

CATEGORY: Basic Research

DESCRIPTION: Develop systems to identify/diagnose toxins or infectious diseases in biological samples at sub-nanogram levels using amplification immunoassay or other technologies. Development of means of detection or diagnosis of exposure to toxins or infectious diseases of interest. Systems must be simple, sensitive, specific, reliable, and rapid for field use, without cumbersome equipment requirements. Systems should be applicable to biologic matrices such as blood, urine or other clinically obtainable samples. Toxins of principal interest include ricin, microcystin, botulinum toxin, saxitoxin, staphylococcal enterotoxins and clostridial perfringens toxins as well as other low molecular weight, peptide, and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases (e.G. Vee). Ability to identify/diagnose engineered organisms would be of special interest. Diagnostics for channel active toxins, pre- and post-synaptic toxins, and protein syntheses inhibitors are also of interest.

Phase I: Show proof-of-principal.

Phase II: Show utilization of the system for a variety of toxins in a variety of biologic matrices.

Potential Commercial Market: Several toxins and infectious agents that present a military threat also pose a significant public health hazard. These diagnostic kits would be of great value in determining the cause of outbreak of food poisoning or undetermined infectious disease.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-248 TITLE: Remote Water Quality Evaluation

CATEGORY: Engineering Development

OBJECTIVE: Determine feasibility and develop hardware and software to determine quality of water at remote locations.

DESCRIPTION: The corps of engineers has developed satellite imaging capability to detect water resources throughout the world. It is proposed to examine application of this capability to determine some basic health-related water quality parameters at remote locations.

Phase I: Explore concepts and determine feasibility for determination of water quality parameters by remote sensing.

Phase II: Develop bread-board system for testing remote sensing concepts.

Potential Commercial Market: Assessment of environmental quality and detection of environmental degradation.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-249 TITLE: Delivery Of Vaccines By Biodegradable Polymeric Microcapsules With Bioadherence Properties

CATEGORY: Basic Research

OBJECTIVE: To demonstrate the feasibility of biogradable microspheres for the encapsulation of vaccines with or without immunoadjurants which would evoke complete protection for a duration of at least one year by single administration.

description: To achieve maximum protection, most vaccines require two or three booster doses, causing logistical difficulties. Furthermore, parenteral administration of the vaccine by trained medical personnel considerably increases the cost of vaccination. Therefore, biodegradable microspheres for the encapsulation of vaccines with or without immunoadjuvants are needed which would evoke complete protection for a duration of at least one year by single administration. Toxins of principal interest include ricin, microcystin, botulinum toxin, saxitoxin and staphylococcal enterotoxins, clostridial perfringens toxins as well as other low molecular weight, peptide and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases (e.G. Vee).

Phase I: Demonstrate feasibility in laboratory animals, using a vaccine against agents listed above.

Phase II: Extend to include preclinical trails to support ind submission.

Potential Commercial Market: Microencapsulationof vaccines present a significant advancement in vaccine technology by allowing one immunization to replace a vaccine and several boosters. All commercial vaccine manufacturers would be a potential commercial market for development/utilization of this technology.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-250 TITLE: Development Of In Vitro And Animal Model Tests To Assess User Acceptability Of Topical Skin Products

CATEGORY: Exploratory Development

OBJECTIVE: To develop and validate an in vitro and/or for an animal model test that will serve as a predictor of user acceptability in humans for topically applied skin products.

DESCRIPTION: The u.S. Army is currently developing solider use, skin products to serve as topical skin protectants (tsp) and reactive topical protectants (rtsp) to protect soldiers from the dermal threat of chemical warfare agents. Candidate TSPS and RTSPS are evaluated for efficacy, safety, stability and compatibility with other soldier use and chemical agent detection systems. Another critical that must be fulfilled is user acceptability. However, since these materials are regulated by the fda as drugs, human testing for user acceptability cannot be performed until the products are well along in the developmental process. To move this to an earlier stage of development, an in vitro or animal model test is required that would allow an assessment of user acceptability. The test must be validated by human testing and serve as a good predictor for user acceptability.

Phase I: Survey, test and establish methodologies that permit assessment of the characteristics of topical creams and ointments using an in vitro and/or an animal model that can be correlated with human user acceptability. Specifically, correlates of subjective human assessments of tackiness, oiliness and smoothness should be sought. Considerations of methodologies to accomplish this goal should include rheological, resistance, shear and interfacial tension measurements, but should not exclude other methodologies. Development of models should consider the use of a collagen matrix, leather or human skin equivalents as potential in vitro examples and the hairless guinea pig (HPG) as the in vivo animal model. The HGPS already used extensively for in-house efficacy testing.

Phase II: Design, establish and execute a testing procedures to validate the previously developed in vitro and/or animal model against user acceptability in humans.

Potential Commercial Market: Evaluation of user acceptability is a necessary step in the development of skin products in industry. A less costly means of performing this evaluation earlier in the development process would be expected to very useful.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-251 TITLE: Mobile Field Waste Incinerator

CATEGORY: Engineering Development

OBJECTIVE: Develop a small, mobile incinerator for field disposal of solid waste, human waste and hospital waste.

DESCRIPTION: There is a need to incinerate solid waste, human (sanitary) waste and hospital (infectious) waste in the field. This could be achieved by a small, mobile incinerator, a family of such incinerators, or a single incinerator adaptable for each use. Such a device must be capable of operation using military power supply and/or fuel and must be transportable by equipment available to field units. Economy of size and energy consumption are essential requirements; a secondary requirement would be a minimal heat signature.

Phase I: Identify operational criteria for a mobile field incinerator, including minimum temperature and residence time, size of incineration chamber and requirements for emissions control (for use during training). Deliverables will include a conceptual design package, which can be based on a loading rate up to and including that suitable for a 400 bed field hospital.

Phase II: Design, construct and test a preprototype incinerator.

Potential Commercial Market: Parks, construction sites, disaster areas, open air concerts.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-252 TITLE: Medicinal Chemistry Synthesis Of Potential Drugs Effective Against Toxic Agents Of Biological Origin

CATEGORY: Basic Research

OBJECTIVE: Develop prophylactic/therapeutic compounds for treatment of intoxications caused by toxins of biological origin.

DESCRIPTION: Toxic agents of biological origin such as botulinum toxins, saxitoxin, staphylococcal enterotoxins, ricin, etc. Are potential threat agents for which protective measures are required. There is an interest in chemical compounds which will prevent (pretreatment) and/or counteract (antidote/treatment) the toxic effects of such agents. Airway or systemic applications will be considered. The drugs need to be reasonably non-toxic and fast acting. The compounds prepared are to be fully characterized and of high purity (>99.5%), For screening against the targeted threat agents.

Phase I: Demonstrate efficacy of the compound in a model system.

Phase II: Demonstrate efficacy against other toxins or conduct preclinical trials in support of ind submission.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regime exists. Chemical compounds for treatment or protection against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-253 TITLE: Development Of An Aviator Restraint System Locking Device

CATEGORY: Basic Research

OBJECTIVE: Develop a locking device, for use on u.S. Army helicopter personal restraint systems that will allow no more than 2.5cm Of webbing extension exclusive of webbing stretching lock under all potential crash conditions. Inadvertent lock activation during normal use shall be minimized.

DESCRIPTION: Current restraint system locking devices are activated by strap acceleration and utilize a pawl and ratchet mechanism to lock the reel. This technology has allowed unacceptable upper torso flailing during army helicopter crashes resulting in serious and occasional fatal injuries to pilots. This situation has been compounded in "crashworth" helicopters equipped with energy attenuating landing gear and crew seats where crash force onset rates and peak accelerations experienced by the occupants are markedly reduced. Resolution of this problem will require the development of new concepts in webbing locking devices. It is desirable for the device's lock activation to perform independently of the occupant's torso displacement since the intent of the restraint system is to prevent occupant motion. An activation reliability level of 100 percent when subjected to various crash loadings is desirable while maintaining minimal inadvertent activation during normal flight duties.

Phase I: Review current state-of-the-art technologies in the aerospace and automotive industries and explore new ideas in sensing crash force accelerations and providing restraint system locking. In addition, develop appropriate test conditions and methods to evaluate the new restraint system locking devices. Proposed concepts should consider all helicopter types under all possible crash and near-crash conditions. Fulfillment of this phase should include a state-of-the-art technology review critique, a proposal for at least three separate locking device concepts, and appropriate test methods for each locking device technology.

Phase II: Provide working prototypes of two concepts selected by the government from the concepts proposed in phase I and apply at least one test method from phase I to detail the performance of each concept prototype.

Potential Commercial Market: Personal restraint system locking devices developed during this project can be used in commercial and military aircraft and the concepts evaluated in this work may lead to an innovative product for passive restraint in other vehicle types including automobiles.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-254 TITLE: Medical Countermeasures Against "Toxic Agents Of Biological Origin"

CATEGORY: Basic Research

OBJECTIVE: Refine or develop new model systems to determine pathophysiologic mechanisms. Provide new methods of therapy and prophylaxis for biological toxins.

DESCRIPTION: Biological toxins, such as botulinum, ricin, anthrax, and staphylococcal enterotoxins are agents for which protective measures are required. The molecular sites of action of several of these toxins have been identified, however, cellular and organ pathophysiology as well as integrative mechanisms in whole animal models require further study. Research proposals designed to develop in vitro model systems and determine pathophysiologic mechanisms for developing potential medical countermeasures such as vaccines, antibodies, or drug prophylaxis and treatment regimens are strongly encouraged.

Phase I: Demonstrate usability of new methodology for a single toxin.

Phase II: Demonstrate usability of methodology for a variety of biological toxins from various diverse sources, plant, bacteria, etc.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regimen exists. Study of the molecular sites of action leading to medical countermeasures against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-255 TITLE: Development Of Anthropometric Analogous Headforms

CATEGORY: Basic Research

OBJECTIVE: Conduct a scientific review on the mass properties, biodynamic response, skin properties, and the occipital and cervical pivot locations of the adult male and female head and neck. Apply this information to the development of three different sized manikin headforms to be used in testing military crashworthy and ejection seats. These headforms should be representative of actual mass properties, equivalent skin thicknesses, retrofit to existing hybrid iii and adam manikins through the denton 6-axis load cell, contain a tri-axial accelerometer located at the head center of mass, and the occipital pivot shall be anthropometrically located.

DESCRIPTION: Currently accepted manikin headforms used by the department of defense include the hybrid ii, hybrid iii, and adam. Anthropometrically, these headforms are undefined and do not represent any specific percentile aviator. Three anthropometrically sized headforms have been developed by USAARL for evaluating the protective capabilities of aviator headgear. Manikin headforms are required which represent the anthropometry of these three headforms. The manikin headforms must possess realistic and reproducible mass properties, a tri-axial accelerometer located at the head center of mass, skin thickness equivalent to humans, an anthropometrically located occipital pivot, and be compatible with the denton 6-axis load cell and retrofit to existing hybrid iii and adam manikins.

Phase I: Conduct a scientific review and prepare a report on the mass properties, biodynamic response, skin properties, and occipital pivot location of the adult male/female head and neck. Design three headforms (small, medium, and large), that possess the appropriate mass properties, skin properties, anthropometrically located occipital pivot, have a tri-anial accelerometer located at the head center of mass and be compatible with the denton 6-axis load cell. The anthropometric features of the three headforms shall be representative of the three usaarl headforms.

Phase II: Fabricate one fully instrumented headform of each size and evaluate the following properties: Anthropometric dimensions, mass properties, and the biodynamic response as tested on a hybrid iii head/neck calibration test stand.

Potential Commercial Market: These headforms would be marketable to the automotive industries, protective headgear developers and manufacturers, and dod testing agencies.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-256 TITLE: Cellular Immune Response To Diseases Of Military Importance

CATEGORY: Basic Research

OBJECTIVE: To develop new, sensitive, quantitative tests to monitor cellular immunity as a response to vaccinations.

DESCRIPTION: Recovery from, protection against and perhaps the disease process itself, of several diseases of military importance are mediated by cellular response or immunity. Sensitive, quantitative, and easily applied tests to detect relevant responses are needed both in evaluation of the immune status of antibody-negative subjects and to monitor the disease process and vaccine development. Typical systems in which such responses are thought to be biological relevant include diseases caused by q fever and the staphylococcal enterotoxins.

Phase I: Demonstrate proof-of-principle using an organism from those listed.

Phase II: Demonstrate applicability in specimens from infected individuals.

Potential Commercial Market: Monitoring cellular immunity may be used to evaluate immune status of antibody-negative individuals vaccinated against a variety of infectious diseases. Development of a sensitive quantitative test of cellular immunity would be of potential interest to all vaccine manufacturers in order to quantify levels of protection demonstrated by a new or existing vaccines.

TECHNOLOGY CLUSTER: A-8
TOPIC: A 257 TITLE: Insert Hearing Protector With Communications Enhancement For High Intensity Impulse Noise Environment

CATEGORY: Basic Research

OBJECTIVE: Develop an insert hearing protector with communications enhancement for high intensity impulse noise environments.

DESCRIPTION: The hearing protective device must be capable of amplifying ambient acoustic signals to increase the wearer's ability to detect and localize low level sounds. The output of the device, in the occluded ear canal, shall not exceed levels which are considered hazardous to hearing. The device design will minimize self generated noise and provide flat frequency response to maintain highest fidelity for the transfer of sounds to the ear. The device shall fit into the ear of the wearer and be compatible with equipment normally used by the soldier. Comfort and user acceptance are important factors in the design of the device.

Phase I: A detailed study concerning insert hearing protection with face-to-face communication capability shall be accomplished. Talk-through characteristics needed to improve communications, detection and localization for personnel with normal hearing or mild to moderate NIPTS shall be established. Develop specifications for a device which conforms to results of the study and meets requirements stated in the above description. Provide design proposals to usaarl for review and selection for further development.

Phase II: Develop prototypes based on phase I design proposals. Quantify electro-acoustic characteristics and provide samples to USAARL for additional evaluation. Deficiencies identified in these evaluations will be used to establish final design criteria for the device. A sufficient number of final design criteria devices will be submitted to usaarl for laboratory and field studies.

Potential Commercial Market: High noise level industrial areas requiring conversation.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-258 TITLE: Human Immuno-deficiency Virus (HIV) Research

CATEGORY: Basic Research

OBJECTIVE: Study the natural history of hiv infection, virus and immune response, chemoprophylaxis and vaccine prevention efforts, and hiv transmission.

DESCRIPTION: Research will be conducted to maximize the use of unique characteristics of military populations such as the broad cross-sectional nature of the community, their potential to be deployed to almost any area of the world, and the total susceptibility of the group to the disease. Areas of research with military relevance include the following: 1) identification, isolation and characterization of hiv strains from diverse geographic locations. 2) Development of improved assays for diagnosis and epidemiological surveys. Development of experimental animal models of disease. 3) Risk assessments and methods of evaluating behavior modification to reduce risk of infection.

Potential Commercial Market: Applicable to world wide health problem.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-259 TITLE: Development Of A Portable, Ultralow Freezer For Preservation Of Biological Products In An Austere Environment

CATEGORY: Exploratory Development

OBJECTIVE: Develop a lightweight, portable freezer, capable of maintaining temperatures of at least -80 degrees centigrade to preserve temperature sensitive biological materials.

DESCRIPTION: New biological products are being engineered for the emergent care of trauma victims and for the prevention and treatment of diseases. By virtue of their chemical nature, these products are heat sensitive and must be stored at very low temperatures to preserve their activity. Bulky insulation and heavy compressor(s) required to reach low temperatures preclude the use of commercial freezers in the field medical environment. To ensure the availability of biological products under these circumstances, there is a requirement for an ultralow freezer that (a) can reach and maintain at least -80 degrees centigrade, (b) has a capacity of about 14 cubic feet, and (c) operates on 110/220 volts ac and 24 volts dc. The freezer should incorporate new technologies in insulation and refrigeration to reduce unit weight and size and to increase its efficiency and durability.

Phase I: Incorporate extant technologies into a conceptual design package for a portable ultralow freezer. The package must document the potential of components to meet requirements for a lightweight, efficient, and durable product that can maintain at least -80 degrees centigrade.

Phase II: Develop and deliver at least one fully operational prototype ultralow freezer with documentation elaborating on its design and function and with data verifying its operational characteristics.

Potential Commercial Market: Ultralow freezers have broad application in the scientific and medical communities.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-286 TITLE: An Analysis of Soldier Biomechanics Using Ambulatory Monitoring Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop and/or adapt instrumentation and techniques for assessing, predicting, and improving the biomechanics of human performance through ambulatory monitoring.

DESCRIPTION: The biomechanics of human motion is fundamental to the execution of nearly all functional tasks in civilian and military environments. Under conditions in which there are no internal or external constraints, such motion exhibits basic characteristics that contribute to efficient performance. In reality, however, human motion is rarely performed without some encumbrance. Heavy loads, personnel protective clothing, fatigue and a variety of other extraneous factors may seriously compromise performance. When individuals perform specific tasks (e.g., lifting, reaching, and walking), it is important to quantify the motion changes that are imposed by nonstandard conditions in order to predict the dynamic changes that occur when unexpected demands are placed on the biomechanical system. More importantly, defining movement strategies that will significantly improve performance in critical situations can be accomplished by a biomechanical analysis of motor behavior using ambulatory monitoring techniques. Ambulatory monitoring refers to the use of a continuous recording system to evaluate kinematic function in the actual performance state. Typically, a miniature portable device is attached to a subject during performance of a specific activity, and the desired information is recorded automatically for later retrieval. The major advantage of this method is that it employs instrumentation that does not physically restrict the subject and it allows a given task to be performed under normal conditions without the use of artificial laboratory environments. Using such monitoring devices, the ultimate goal of the project is to derive biomechanical solutions that will enable the soldier to function in a more efficient manner during the execution of critical tasks. Additionally, a record of movement is made throughout the duration of the task which can be decomposed and provide input for graphical analysis of motion using computerized human models.

Phase I: During this phase, an ambulatory monitoring technique should be selected and used in an empirical study of one military task performed under normal and atypical conditions. A biomechanical analysis should then be made, demonstrating that it is possible to form quantifiable and functionally meaningful distinctions in performance among various environmental conditions.

Phase II: Phase II should: (1) expand the Phase I empirical study to a larger set of military-related tasks; (2) make available a graphics software system for immediate viewing of the experimental data, in the form of recreating the experimental trial with an animated human figure; (3) develop a predictive model that will accommodate untested circumstances; and (4) derive results for enhancing soldier performance under nonstandard conditions.

Potential Commercial Market: Ambulatory monitoring is widely used in the medical field. Cardiac and neurological assessments have been enormously improved by such monitors. An ambulatory monitor for kinematic and kinetic data

acquisition together with evaluative procedures will have significant commercial potential, particularly in the field of rehabilitation, as a unique clinical instrument for disability assessment and patient management. Moreover, a biomechanical monitoring system integrated with graphical animation software will provide human factors engineers with a powerful tool to assess the impact of clothing and equipment on the biomechanical performance of humans in actual working environments.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-343 TITLE: Develop an Enzyme or Fluorescent Linked Anti-body Based Biological Agent Detection/Assay System for Particulate Antigens

CATEGORY: Exploratory Development

OBJECTIVE: Develop a sensitive assay method to minimize the number of steps needed to equate the number of organisms or mass of antigen present for potential commercial Phase III application.

DESCRIPTION: The biological agent detector program has placed demands on the test facility at Dugway Proving Ground to be able to detect and quantify aerosolized particulate challenge material (antigen quantity) by physical means. Efforts to develop a sensitive assay for Bacillus subtilis var. niger during the latter part of FY 92 have been less than successful. Overall requirements are to develop an enzyme linked or fluorescent linked antibody-based assay system for particulate antigens (i.e. BG, MS-2, bacteriophage) that can be equated to number of organisms or mass of antigen present in a given sample. The sample material will be composed of viable and non-viable microorganisms. The detection/quantification assay system should be similar to the standard enzyme-linked immunoassay (ELISA) or the enzyme-linked immunofiltration assay (ELIFA). Other suggestions might include a piezoelectric crystal/antibody approach or a fluorescent antibody used in a microscope assay. It would be desirable, from an operational standpoint, to minimize the number of steps involved in performing the assay. For example, ideally, it might involve adding the unknown sample or standards to a labelled antibody, incubate the fluid and have the particulate/antibody comple remain on the filter to be read by fluorescent concentration. The PANDEX (now IDEXX) corporation fluorescent concentration analyzer seems suitable for such a task.

Phase I: Provide prototype kit which demonstrates technology feasibility for producing assay reliably.

Phase II: Provide shelf-type kit (one-year shelf life or better) for in-house assay production capability.

Potential Commercial Market: *Significant potential for use in detection of airborne* and waterborne particulates, especially in environmentally controlled areas such as hospitals, laboratories, etc..

A-9 ENVIRONMENTAL AND GEO SCIENCES (I.E. ENVIRONMENTAL PROTECTION AND SPACE)

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-046 TITLE: Improved Luminous Tritium Sources

CATEGORY: Exploratory Development

OBJECTIVE: To make a safer, improved light source, containing 90% less tritium, for Army, Air Force & Navy users, and thus increase the source's applications and possibilities.

DESCRIPTION: Within the DOD there are over 1 million curies of tritium in their instrument lamps. The cost per curie is \$3.19. This effort will reduce the \$3,190.00 plus cost to less than \$300.00. To achieve this savings a special machine which produces microspheres will have to be modified to enable the introduction of tritium gas and phosphors into the microspheres. The result will enable a safer brighter light source with only 10% of the tritium previously required.

Phase I: Develop methodology for design and implementation of a system which will produce improved luminous tritium sources in the form of glass microspheres. These sources will be for illuminating instruments used by the Army, Air Force and Navy. Develop and define conceptual lamp designs for two selected Army fire control instruments requiring luminous sources. The improved source will have a five year useful life expectancy goal.

Phase II: Develop a full up laboratory prototype microsphere producing system capable of inserting controlled increments of phosphors and tritium gas into glass microspheres. The increments of phosphors and tritium will be optimized to create a luminous source containing a fraction of the tritium gas that an equivalent status quo luminous tritium source would contain. Two optimized microsphere arrays will be fabricated equivalent to two standard types of 10 curie lamps used in Army Fire Control Devices.

Potential Commercial Market: The commercial potential is very high in providing safer airline passenger exit signs at lower cost. The tritium sources will enable economical long-life instrument lighting for airline cockpits and motor vehicle cabs. In its final packaged form the tritium radiation hazard will be reduced to being only negligible in severe accidents. Since the source does not require electricity, it can be used as a fire safety device in homes and industry providing, at night, easy to follow illuminated directions to fire exits, alarms, phones, etc.

OSCR: A significant army generic cost driver involves electrical/mechanical replacement costs. Status quo electrical items including large and small lamps and associated hardware, housing, switches, contacts, connectors and power sources. These items are limited life components and cause most of the significant electrical/mechanical replacement costs. Many of these lamps can be replaced by the improved long life luminous tritium sources which do not require power sources, wires, switches, etc. and their associated hardware. The efficient improved source will use only about 10% of the tritium presently required by DOD systems. Almost $3M will be saved by the Army by reducing the current quantity of tritium in use, if the new source is incorporated. This new long life light source should save at least $3M annually.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-050 TITLE: Development of a Chemical/Mechanical High Rate Process for the Detection of Residual Stress in 5.56mm Brass Cartridge Cases

CATEGORY: Engineering Development

OBJECTIVE: The objective of this program is the development and demonstration of a real time chemical or mechanical process for the determination of residual stress in 5.56mm brass cartridge cases after they have been annealed. The current test for determination of residual stress is conducted using mercurous nitrate to accelerate the formulation of cracks in the brass cartridge case as a result of any residual stress remaining after cartridge case anneal. Mercury compounds are recognized as known environmental and safety hazards. The process developed under this SBIR is intended to replace the current test used at Lake City Army Ammunition Plant (LCAAP). Upon completion of Phase I, the contractor will have demonstrated the feasibility of a new real time process for the determination of residual stress in 5.56mm cartridge cases. Upon completion of Phase II, the contractor will have fully developed and demonstrated this process for determining the residual stress in 5.56mm brass cartridge cases and demonstrate process capability to operate at the rate of 1200 parts per minute and be capable of being integrated into the 5.5mm cartridge case fabrication production process. Upon successful completion of Phases I and II, a Manufacturing Methods and Technology (MMT) program would then be submitted to place and integrate such a process into the case fabrication line at LCAAP.

DESCRIPTION: Residual stress remaining in brass cartridge cases could result in cracks or splits during extended ammunition storage. Defects such as cracks or splits could pose a safety hazard to soldiers when firing such ammo from their weapons. The current process for the determination of residual stress in 5.56mm brass cartridge case is accomplished as per ASTM B 154-92 Mercurous Nitrate Test for Copper and Copper Alloys. This test employs a mercurous nitrate solution to test in-process cartridge cases and fully assembled cartridges. Mercury accelerates the cracking or splitting of the cartridge case caused by any residual stress remaining in the case after case anneal. The test requires 30 minutes to complete. Mercury compounds pose known safety and health hazards to personnel requiring that extreme precautions be taken during its handling and use. In addition, the disposal of mercury waste in landfill as is currently done can pose a serious environmental hazard and may become illegal in the near future. It is intended that this program develop a process for the determination of residual stress in cartridge cases which would eliminate the use of mercurous nitrate, a known environmental and health hazard. At the same time this process shall be capable of operating real time in the cartridge case fabrication line at the rate of 1200 cartridge cases per minute.

Phase I: A search is to be conducted for the identification of new methods/approaches to residual stress determination which do not have the hazards associated with the current mercurous nitrate test. These methods should be capable of real time operation of 1200 parts per minute. A selection process would be conducted to determine one or two viable processes/tests. This, in conjunction with testing and analysis, would be used to determine the feasibility of utilizing an identified process/test as a replacement for the current mercurous nitrate test. The contractor shall determine the advantages and disadvantages of each test/processes identified as a viable solution to the problem and which meet program objectives. A final determination will be made by the government as to which process will be pursued in Phase II.

Phase II: The contractor shall fully develop the most viable process as is determined in Phase I. He shall demonstrate its ability to determine residual stress at an operating rate of 1200 parts per minute. The process shall be capable of performing accurate stress measurements with little or no interference from normal variations found in the manufacturing process such case thickness, trace impurities, case curvature, etc. The process shall be capable of being integrated into the cartridge case fabrication at LCAAP.

Potential Commercial Market: The potential for a Phase III effort for commercial applications for this program is considered to be good. Most commercial producers of sporting ammunition and ammunition for law enforcement purposes utilize a mercurous nitrate test for the determination of residual stress in brass cartridge cases. Mercurous nitrate is recognized as a health and environmental hazard. Currently, spent mercury solution is disposed of in a landfill. This method of disposal will be banned in the near future. An environmentally safe and non-toxic method of residual stress determination will eventually have to be found. The results of this effort could be directly applied in the commercial segment of the ammunition market since that also now employ the mercurous nitrate test for residual stress determination in brass cartridge cases.

OSCR: The development of in-line non destructive inspection methods for detecting residual stress in brass cartridge cases will result in reduced operating and support costs associated with metal parts fabrication. Presently, the inspection of brass cartridge cases is conducted "off line" using mercurous nitrate which requires a minimum of 30 minutes to complete testing. In this time, approximately 36,000 defective cartridge cases can potentially be fabricated before a environmental safety and health hazard. An in-line inspection method would identify a residual stress problem in real time allowing for an immediate change in the annealing process and thereby eliminate a large amount of scrap material. Elimination of the disposal costs of mercurous nitrate is another potential area cost savings. A reduction/elimination of a safety and health hazard and its associated cost not the least of which may be potential legal action/lawsuits would result in additional costs savings.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-054 TITLE: Electro-chemical Machining of Refractory Materials for Gun Barrels

CATEGORY: Exploratory Development

OBJECTIVE: Develop and Demonstrate Electro-chemical Machining (ECM) Processes for Refractory Materials used in Gun Barrel Liners

DESCRIPTION: New gun barrels are being developed utilizing internal liners of refractory materials of various metallurgical combinations. These materials cannot be machined by conventional machining processes. Electro-chemical machining in the form of an "Electronic Broach" has been developed for conventional gun barrel steels. The new refractory gun barrel liners require development of new electrode materials and process parameters to successfully machine these liners. Some liners are homogeneous and some are composite so as to maximize heat resistance, resist wear and maintain strength. It is necessary to develop specific ECM Processes and to establish machining parameters to obtain high quality surface finish and to maintain precise internal dimensions and rifling configuration for both constant twist and gain twist rifling.

Phase I: Develop methodology and design for implementation of optimum electrode material, electrolyte and electrode clearances that are suitable for various power inputs and cutting speeds.

Phase II: Develop laboratory prototype and demonstrate processes. Finalize parameters.

Potential Commercial Market: Commercial market potential is considered good. Components of refractory materials are used in high temperature applications such as gas turbine engines, heat exchangers, and high temperature valves.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-055 TITLE: Cleaning of Depleted Uranium from Metal Parts

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a system capable of cleaning depleted uranium from metal parts.

DESCRIPTION: The disposition of metal parts from 120mm tank ammo cartridges with depleted uranium (DU) penetrators has been a problem for some time. Previous demilitarization procedures have provided for the crushing of the core and the metal parts and die burial of the remains. Not only does this threaten the environment around the dump site, but it also dismisses the potential cost savings of reusing the metal parts. The metal parts have come in contact with the DU core and have become coated with DU oxides (UO_2 and $UO_4 \cdot 2H_2O$) as the core has aged and oxidized. The feasibility of cleaning these oxides from these metal parts has never been investigated. NOTE: It is intended that cleaning of metal parts should be done at a projectile or cartridge assembly facility.

Phase I: Develop process for removal of DU particulate from metal parts. Define conceptual design for facilities necessary in support of removal process.

Phase II: Design and construct prototype DU removal facility in support of DU removal process.

Potential Commercial Market: Depleted uranium (DU) has many commercial uses such as ballast weights for ships and planes, radioactive shielding materials, paint and dye pigments and others. Any machinery of materials in contact with the DU would need to be surveyed and cleaned periodically. Therefore, a process developed for the Army would have strong commercial application.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-056 TITLE: Preferred Orientation in Tungsten Heavy Alloys (WHA)

CATEGORY: Exploratory Development

OBJECTIVE: Develop technology to impact preferred orientation in polycrystalline tungsten heavy alloys to improve their ballistic performance. Military applications include kinetic energy penetrators, shaped charge liners, EFPs and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools.

DESCRIPTION: Tungsten heavy alloys and depleted uranium alloys have found usage in long-rod kinetic-energy ammunition. Attempts to improve the ballistic performance of tungsten heavy alloys have centered on improving the mechanical properties. These attempts, however, have been less than fully successful. Recent investigations to understand the penetration mechanisms using single crystal tungsten penetrators having rod axes parallel to the (100), (110), and (111) directions showed three distinct deformation behaviors and ballistic performances. The (100) orientation had penetration performance equalling that of depleted uranium alloy. The intent of this development effort is to develop technology to impart preferred orientation in polycrystalline tungsten alloys. Desirable technical approaches may include (but are not limited to) solid-state zone refining and advanced thermo-mechanical processing treatments.

Phase I: Develop technologies to impart preferred orientation in polycrystalline tungsten alloys. Develop the processing-orientation correlations. Conduct high strain rate testing and fracture analysis.

Phase II: Select and optimize the most promising material and processing technique from Phase I and fabricate sub-scale ballistic penetrators. Test and compare the ballistic performance with depleted uranium alloys.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include kinetic energy penetrators, shaped-charge liners, EFP's, and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools. Development of advanced tungsten materials and/or processes under the SBIR program will allow advancement in both military and commercial fields. An alternate material to replace the environmentally-sensitive depleted uranium in all DOD applications will be by far the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented rod penetrators are a few of the many examples. Developed technology will also benefit the commercial products mentioned above.

OSCR: The SBIR proposal to develop new tungsten alloys and processing technology aims to markedly reduce the environmental, logistical and life cycle cost burden associated with the present use of radioactive depleted-uranium material in all DOD armament systems. The approach of the proposal is to develop a new generation of tungsten alloys and/or processing technologies that will enhance the ballistic performance of WHA to be equivalent or better than depleted uranium alloys. The goal is to make tungsten alloys a viable cost-effective replacement for the radioactive depleted uranium used in DOD munitions, and thereby eliminate the major environmental concerns that presently burden the DOD. The replacement of depleted uranium in munitions with an environmentally in-offensive tungsten alloy will have major cost benefits. These benefits will extend throughout the life cycle of these anti-armor kinetic energy penetrator rounds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-057 TITLE: Coated Tungsten Alloy Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop coating technology to fully or partially coat tungsten or tungsten alloy rods with material susceptible to localized failure during Armor Penetration. This technology can be applied to kinetic energy penetrators, shaped charge liners, EFPs and Armor. Commercially these alloys are used for gyroscopes, semiconductor substrates, radiation shields, and machine tools.

DESCRIPTION: High density is one of the key attributes of successful kinetic energy penetrator materials. Tungsten heavy alloys (WHA) and depleted uranium are two materials which possess required properties for ballistic penetration. Depleted uranium alloys, however, are more effective penetrator materials. Their ballistic superiority is attributed to their localized failure during penetration. Recent environmental pollution concerns related to the use of depleted uranium have spurred significant interest in enhancing the ballistic performance of tungsten alloys. The current technical approach is to induce thermo-mechanical instability in WHA's by replacing the nickel-base matrix with one or more materials susceptible to adiabatic shear localization. However, since the matrix is a small constituent of WHA, it is unlikely that a new matrix alone can induce localized failure of the whole composite. Thus, to enhance the effect of a new matrix material, it should be concentrated in specific areas of the penetrator rod. Development of a coating/surface modification technology is required to enhance the ballistic performance of tungsten and tungsten heavy alloys. Such a coating must be adherent and crack-free and must be able to withstand ballistic impact.

Phase I: The goal of Phase I is to identify candidate materials based on rational and scientific considerations. Conduct coating experiments on tungsten rods to partially or fully coat with selected materials to a coated composite density >17g/cm3. Evaluate the coating quality with respect to bond strength, microstructure, porosity and microcracks.

Phase II: Select and optimize the processing of two materials from Phase I. Fabricate sub-scale ballistic test penetrator with fully dense coatings in different configurations. Conduct terminal ballistic tests and compare the data with depleted uranium penetrators. Conduct fracture analysis of recovered penetrator materials.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include kinetic energy penetrators, shaped-charge liners, EFP's, and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machining tools. Development of advanced tungsten materials and/or processes under the SBIR program will allow advancement in both military and commercial fields. Alternate materials to replace the environmentally sensitive depleted uranium in all DOD applications will by far be the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented-rod penetrators are few of the many examples. Developed technology will also benefit the commercial products mentioned above.

OSCR: The SBIR proposal to develop new tungsten alloys and processing technology aims to markedly reduce the environmental, logistical and life cycle cost burden associated with the present use of radioactive depleted-uranium material in all DOD armament systems. The approach of the proposal is to develop a new generation of tungsten alloys and/or processing technologies that will enhance the ballistic performance of WHA to be equivalent or better than depleted uranium alloys. The goal is to make tungsten alloys a viable cost-effective replacement for the radioactive depleted uranium used in DOD munitions, and thereby eliminate the major environmental concerns that presently burden the DOD. The environmentally in-offensive tungsten alloy will have major cost benefits. These benefits will extend throughout the life cycle of tense anti-armor kinetic energy penetrator rounds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-058 TITLE: Tungsten Alloys with Enhanced Ballistic Performance

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a Tungsten Penetrator Material that is a viable substitute to depleted uranium penetrators. Alternate materials will replace the environmentally-sensitive depleted uranium in all DOD applications such as SADARM, replacement of M829A1 KE round, unguided hyper-velocity projectiles, and the X-rod program.

DESCRIPTION: Depleted uranium alloys are the material of choice for long-rod kinetic energy ammunition. Their ballistic superiority over tungsten heavy alloys is attributed to the localized failure these alloys exhibit during penetration of armor. The environmental pollution concerns related to the use of depleted uranium alloys, however, have spurred significant interest in enhancing the ballistic performance of safer tungsten alloys. Prior tungsten alloy development programs achieved significant improvements in mechanical properties; but failed to realize any improvement in penetration performance. More recent development efforts utilize an approach to induce a thermo-mechanical instability in the tungsten heavy alloys by replacing the nickel base matrix with one or more materials susceptible to adiabatic shear localization. The matrix, however, constitutes only a small percentage of the two-phase composite microstructure. Pure tungsten is the major constituent; therefore, it is unlikely that changes in the matrix alone can induce favorable failure modes. Thus, totally new tungsten alloys based on novel microstructure and advanced tungsten particles are needed to fabricate tungsten heavy alloys with altered and beneficial deformation failure modes. Desirable technical approaches to achieve alterations in deformation behavior of pure tungsten do

not have to solely rely on thermal softing to create localized failure, but also should take advantage of structural or microstructural modifications. This may also include preferred orientation of microstructure.

Phase I: Synthesize novel tungsten alloys which exhibit altered and favorable failure mode as compared to pure tungsten. Device processing technique to produce fully dense monolithic bulk material containing novel tungsten particles.

Phase II: Select and optimize the most promising material/ processing combination addressed in Phase I. Conduct high strain-rate testing to develop property/microstructure correlationships for new alloys. Evaluate fracture mode of various alloys. Demonstrate sub-scale terminal ballistic parity between depleted uranium and tungsten heavy alloys.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include the kinetic energy penetrators, shaped charge liners, EFP's, and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools. Development of advanced tungsten materials and or processes under the SBIR program will allow advancement in both the military and commercial fields. Alternate materials to replace the environmentally sensitive depleted uranium in all DOD applications will by far be the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented rod penetrators are a few of the many examples. Developed technology will also benefit the commercial products mentioned above.

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TECHNOLOGY CLUSTER: A-9
TOPIC: A93-062 TITLE: Development of Environmentally Friendly, Cost-Effective and Scaled-Up Synthetic Processes for New High Energy Density Materials

CATEGORY: Exploratory Development

OBJECTIVE: This project should mature towards industrial production of new more powerful explosives, viz GARDEC HMX, TNAZ, Dinitroimidazole, etc. The Phase II accomplishments toward feasibility of Scale-up preparation will be transitioned for possible commercial production.

DESCRIPTION: Several new explosives are being developed in the ARDEC Energetics & Warheads Division which have high potential for use in munitions to provide enhanced performance. They could be used both as more powerful/insensitive explosives and propellants. The objective of this solicitation is for investigations to scale-up the recently-developed preparative processes to the multi-pound level of a wide variety of energetic materials, viz. alpha and/or beta HMX (produced by the new GARDEC process); 2, 4 dinitroimidazole and TNAZ.

Phase I: a. Determine the feasibility of attaining scale-up quantities of the new explosive compounds TNAZ and 2, 4 dinitroimidazole via the newly discovered synthetic routes. b. Determine the feasibility of scaling up the newly developed GARDEC processes for the production of alpha and beta HMX.

Phase II: Conduct intermediate scale runs to produce multi-pound quantities of alpha/beta HMX, TNAZ and 2, 4 dinitroimidazole via the new chemical processes developed at ARDEC.

Potential Commercial Market: This topic has a high potential for commercialization. Already, HMX and TNAZ scaled-up processes are being investigated by Holston Defense Corporation, Hercules, and Slumberger companies. Dinitroimidazole has a high potential for commercialization since it is a highly likely candidate for DOE applications.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-064 TITLE: Development of Nonpolluting Soldering Technology for Large Production Volume, High Shock Loaded Electronics Circuit Boards

CATEGORY: Advanced Development

OBJECTIVE: Provide specific tested and proven soldering technology which is non-polluting and is suitable for large production volume electronic circuit boards which are subject to high setback, high shock environments such as fuzes, mines, and smart munitions.

DESCRIPTION: Research and develop new soldering technology and waste recovery methods which do not rely on ozone depleting chlorofluorocarbon (CFC) cleaning solvents and do not result in waste product environmental contamination. Investigate use of aqueous cleaning techniques, conductive epoxy adhesive solder, water soluble flux compounds and/or other non-CFC cleaning agents. New method must involve recovery system for any waste product.

Phase I: Research nonpolluting and non-CFC based soldering processes and materials to determine best suitable technology for large scale production of assemblies required to endure extremely high shock environments. Consider aqueous and semi-aqueous cleaning with residue capture and elimination of the need for cleaning; the later being the preferred approach.

Phase II: Develop cost effective nonpolluting, proven and high reliability soldering technology/process, equipment and materials specifically targeted to the large production volume electronics and electrical assemblies which are subject to the extremely high shock/high setback environments associated with cannon, tube or rocket launcher, or air drop emplacement. Define package available to Government ammunition plants and production contractors.

Potential Commercial Market: Nonpolluting soldering technology (including the eventual elimination of lead based solder) is the wave of the future. CFC and other soldering process pollutants will be outlawed in the future. A small business with readily available technical advice and technology (processes, equipment, materials) will be positioned to quickly fill the requirement of an industry searching for alternatives.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-080 TITLE: Aerosol Cloud Imagery Identification and Segmentation

CATEGORY: Exploratory Development

OBJECTIVE: Develop enhanced image processing capabilities primarily for segmentation of smoke/obscurant clouds from multispectral imagery.

DESCRIPTION: Characterization of smoke/obscurant clouds is important for assessing system effects on electro-optical and other electromagnetic sensors operating under "dirty battlefield" conditions. Additionally, this characterization is important for the test, evaluation, and development of smoke and obscurant defensive and countermeasure systems. In order that this characterization be accomplished in three-dimensional space, as opposed to single lines of sight, multispectral imagery is a major part of the instrumentation suite used under field test conditions. The analysis of these data requires that the smoke cloud be identified and then segmented from the scene under study. In most situations, the cloud radiance/luminance is nearly the same as the background against which the observations are being made, which causes automatic segmentation schemes based on edge detection to fail. Possible alternative techniques could be based on, but not be limited to texture analysis, multispectral signature, or artificial intelligence. This topic supports the Reduction of Generic Cost Driver #2, "Causes of Training Ammunition Expenditure Costs" by reducing operating and support costs through an increase in First Round Hit Probability.

Phase I: The goal of this effort will be to develop enhanced algorithms/measurement techniques based upon existing imagery and/or easily obtained observations for the successful automatic segmentation of aerosol clouds from the scene.

Phase II: Evaluation and implementation of the enhanced segmentation scheme on a variety of existing imagery and/or field tests to acquire additional data for analysis of the developed capability.

Potential Commercial Market: A potential commercial market exists in the application of the technique to satellite imagery and the segmentation of meteorological clouds as well as the possible application of advanced techniques for real-time identification and segmentation of aerosol clouds other than smoke and obscurant clouds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-081 TITLE: Scanning Bi-Static Sodar for Measuring Wind Structure Parameter

CATEGORY: Exploratory Development

OBJECTIVE: Develop a scanning Bi-Static Sodar for measuring of the wind structure parameter with height from 50 meters to 700 meters above ground level.

DESCRIPTION: One atmospheric parameter which affects the propagation of sound is turbulence. Turbulence will dramatically affect the amplitude of sound propagating from battlefield targets and the Line-Of-Bearing measurements to the targets. The

types of turbulence involved are the temperature and wind structure parameters. Therefore, to understand the degree of turbulence effects on sound propagating in the atmosphere, the magnitude of the temperature and wind structure parameter must be measured as a function of height above the ground. Currently, a Mono-Static Sodar is used to measure the temperature structure parameter. However, the magnitude of the wind structure parameter will make the largest contribution to the magnitude of the turbulence in the upper air. A Bi-Static Sodar will provide the measurements of both temperature and wind structure parameter with respect to height above the ground. This type of measurement is needed for the development of turbulent acoustic propagation models which will predict the effects of turbulence on the phase and amplitude of sound propagating from tactical targets and its influence on the detectability of those targets. This topic supports the Reduction of Generic Cost Driver #2, "Causes of Training Ammunition Expenditure Costs," by increasing the First Round Hit Probability.

Phase I: Development of a Bi-Static Sodar which will provide measurements of both temperature and wind structure parameter from 50 meters to 700 meters above ground.

Phase II: Evaluation of the performance of the Bi-Static Sodar by conducting field tests in conjunction with in situ measurements of the temperature and wind structure parameter from a tower or other verified techniques of measurements.

Potential Commercial Market: A potential market exists in the development of this type of measurement for use in aviation, obscurant cloud dispersal, and optical propagation.

TECHNOLOGY CLUSTER: A-9

TOPIC: A93-082 TITLE: Normal Mode Analysis of Atmospheric Sound Ducts

CATEGORY: Exploratory Development

OBJECTIVE: Develop fast analysis techniques for determining the effectiveness of atmospheric sound ducts for the propagation of sound.

DESCRIPTION: A sound duct, at the surface, is a region in the atmosphere where sound is refracted back toward the ground and becomes trapped near ground. Optimal acoustic propagation conditions can occur when there is a sound duct present in the atmosphere. However, the effectiveness of the duct for the propagation of sound is dependent on the frequency, turbulence strength, shape of the duct, and acoustic impedance of the ground. Normal mode techniques can provide the ability to perform initial assessment of the acoustic propagation characteristics of a sound duct for a single or multiple tone acoustic signal. This type of analysis capability will allow rapid determination of the impact of a sound duct on the detectability of a battlefield target.

Phase I: Development of the theoretical relationships which determine the acoustic propagation characteristics of an atmospheric sound duct. The propagation characteristics will include the range of frequencies which will propagate well in the duct and what degree of "leakiness" of the duct exists at those frequencies.

Phase II: Development of a software package based upon the theoretical relationships in PHASE I. This software package will be written in ANSI-STANDARD FORTRAN 77, with the output being comprised of the parameters which dictate the effectiveness of a sound duct to propagate sound through it.

Potential Commercial Market: A potential commercial market exists in the application of these techniques in the evaluation of commercial and military noise impact on communities.

TECHNOLOGY CLUSTER: A-9

TOPIC: A93-212 TITLE: Arid Land Revegetation with Blue-Green Algae

CATEGORY: Exploratory Development

OBJECTIVE: Develop a viable inoculation process using blue-green algae (Microcoleus vaginatus) to stabilize and restore ecological function to disturbed lands in arid ecosystems.

DESCRIPTION: Due to the perceived difficulties in restoring arid ecosystems, disturbed lands in those regions have been written off as permanent sacrifice areas. New research has shown, however, that microphytes, particularly blue-green algae, are a critical factor in soil stability and nutrient cycling in arid ecosystems. Long overlooked due to their inconspicuous nature, these organisms may be the key to successful land reclamation in arid regions. Unfortunately, very little is known about requirements for propagation, harvest, storage and inoculation of the organisms.

Phase I: In a laboratory setting, develop methods of propagating, harvesting, and storing (with minimal loss of viability) cultures of Microcoleus vaginatus. Develop methods to inoculate damaged lands with the cultured algae using slurry and/or granular/pelletized techniques.

Phase II: Develop commercial scale apparatuses for propagating, harvesting, storing and applying Microcoleus vaginatus cultures to disturbed lands in arid ecosystems.

Potential Commercial Market: The Departments of Defense, Energy, Interior and Agriculture, as well as various State and private organizations and individuals, are responsible for millions of acres in the arid West. A product that has been proven successful in the reclamation of disturbed arid land ecosystems would have very high potential for commercialization in the United States. A potential market also exists in other arid regions around the world.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-214 TITLE: Heavy Metal Ion Removal by Magnetic Particle Wastewater Treatment

CATEGORY: Exploratory Development

OBJECTIVE: Develop magnetic particle resin technology for use in heavy metal ion removal from wastewater.

DESCRIPTION: The traditional methods of removal of heavy metal ions from industrial wastewaters such as electroplating rinse waters involves the use of ion exchange technology. Ion exchange is plagued by high capital cost, the need for prior clarification and subject to fouling. A number of arsenals and depots such as Toby Hanna Army Depot, PA and Corpus Christy Army Depot employ electroplating technology which generates chrome, nickel and cadmium metal ions requiring removal from the wastewater. A cost effective method is needed for removal of heavy metal ions from small plating operations.

Phase I: Develop and prove the concept of using magnetic particle resins in wastewater treatment. The proof of concept should include a safety and environmental impact study.

Phase II: Develop a prototype magnetic particle technology which takes advantage of the negative charge present on colloidal impurities in sewage, effluence, and raw water. The theoretical treatment process would involve changing the ion charge on magnetite, contacting the effluent, inducing flocculation, clarifying, and release of the impurities from the magnetite.

Potential Commercial Market: The U.S. Army, DOD, and municipal waste treatment facilities all have a need to dispose of contaminated industrial wastewaters.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-215 TITLE: Heavy Metal Adsorption From Combustion Gas

CATEGORY: Exploratory Development

OBJECTIVE: Development of a material or system which would preferentially adsorb heavy metals from a combustion system. Subsequent separation of the material from the combustion gas stream and extraction or concentration of the metals is desired.

DESCRIPTION: Incineration has the potential to be used as the Army's energetic wastes that are generated during the manufacturing process. All researchers int he field of explosives incineration agree that the development of an adequate feed method is the key to successful application and use of this technology. Experts also agree that size reduction as a minimum along with some other form of pre-treatment is important to the incineration process. Heavy metals frequently end up being volatilized and going up the stack. Most of the heavy metals will be regulated as toxic air pollutants under the Clean Air Act of 1990. This SBIR is intended to address the heavy metals and to find a way to capture them before they are exhausted to the atmosphere.

Phase I: Evaluate and prove feasibility of using a material or system to preferentially adsorb or separate heavy metals from a combustion stream.

Phase II: Develop a system and demonstrate.

Potential Commercial Market: The U.S. Army, DOD, and private manufacturers and incinerator operators all have a need to limit heavy metal emissions from combustions processes.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-222 TITLE: Evaluation of Supercritical Fluid Extraction Technology for Decontamination

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate the potential for using supercritical fluid extraction (SCFE) technology for chemical, biological and nuclear decontamination of small, delicate military equipment.

DESCRIPTION: The work will entail a detailed review of the current SCFE technology and evaluate, in detail, its applicability to the decontamination of small items of military equipment.

Phase I: The investigator(s) will make one visit to CRDEC for a briefing on the operational use and requirements for a small equipment decon system. They will then critically evaluate SCFE technology and equipment discussing such topics as the fluids which might be used; how these fluids would be stored and transported; the dimensions and weight of the SCFE apparatus; the anticipated power requirements; methods of moving equipment into and out of the SCFE apparatus; the spraying and/or washing system within the SCF apparatus. The discussions will identify potential problem areas if using SCFE for this purpose, suggest technical approaches to overcome them and consider realistic advances expected in SCFE technology in the coming decade which may impact on the utility of this approach.

Phase II: The investigator(s) will prepare a reduced-size prototype SCFE apparatus suitable for studying the process using small test coupons based upon the SCFE approach which appeared most reasonable in Phase I. Depending on the complexity which would ultimately be required in the field model, this test apparatus would not necessarily have all the features of a full engineering prototype, but will have sufficient capability to allow testing to demonstrate whether the approach will work.

Potential Commercial Market: SCFE is already in use in commercial processing. Development which extends the use of this technique for applications involving hazardous materials could be useful in other industrial situations.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-229 TITLE: Rapid Measurement of Ice Density

CATEGORY: Advanced Development

OBJECTIVE: Develop a system for rapid, accurate determination of density of ice samples obtained in field situations.

DESCRIPTION: Accurate measurements of densities of samples of sea, lake and river ice are necessary to calculate the mechanical and electrical properties of the ice. Likewise, the density of ice formed on objects by supercooled fog and sea spray are necessary to calculate loads caused by icing. Small errors in measured density can make large differences in calculated loads or properties. Two methods currently favored for measuring density are the mass-volume technique and submersion method. In the mass-volume method, the sample is weighed (usually on a portable electronic balance) and the volume measured with calipers. For the submersion technique, the sample is weighed in air and a fluid of known density, and the ice density can be quickly calculated. The submersion method is accurate on bubble free ice, but large errors occur on ice with connecting surface channels. The difficulty with the mass-volume method is generally the accurate determination of volume due to surface irregularities. A field portable method of accurately measuring ice density to an accuracy of 0.002 g/cm (cubed) is required. Sea, lake, and river ice is normally collected by core sampling resulting in samples that are 6 to 15 cm diameter cylinders (depending on auger diameter) and can be 2 to 25 cm in length. Sea spray or atmospheric ice samples may be a variety of shapes or configurations, some with volumes of only a few cm (cubed). Some ice may be permeable, thus, submersion techniques may not be appropriate. It is preferable, but not absolutely necessary, that the technique be non-destructive. Instrumentation and tools for making the measurements should be made rugged, and be packaged such that it can be deployed by one person (making several trips if necessary). AC power will often only be available from a small generator (1.5kva) at the field sites. The measurement technique should work in temperatures ranging from 0 to -40 degrees C.

Phase I: Determine the feasibility of developing instrumentation to accurately measure ice densities in the field conditions described above. Design and develop a "breadboard" system and prove the feasibility of the technique in laboratory tests.

Phase II: Make necessary modifications to Phase I concept and development then design and fabricate a prototype system. The prototype system will be used in field tests to demonstrate its applicability.

Potential Commercial Market: Instrumentation and techniques to measure ice density would be useful to government laboratories, academic institutions and private companies involved in ice research. Depending on the technique adopted, it also may be useful for determining the density of other natural materials, which would considerably expand its commercial potential.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-230 TITLE: Near-Infrared Spectral Reflectances of Earth Materials

CATEGORY: Engineering Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for rapidly measuring the near-infrared reflectance spectra of earth materials and landscape features in the field.

DESCRIPTION: There are many current instruments that are suitable for field measurement of spectral reflectances in the visible and part of the near-infrared region (0.35 - 1 micron). However, there is a great deal of information in the near-infrared spectral signature (1.0 - 2.5 microns) of most earth materials, which allows identification and classification in remote sensing data, as well as more accurate specification of the wavelength-integrated albedo for energy balance calculations. This project requires systematic application of knowledge about large array sensing elements, spectral sensitivity of sensor materials, and integration of instrument packages with small computers to develop a light-weight near-infrared field spectroradiometer. Equipment is required that will reliably, accurately, and rapidly measure spectra in the 1.0 - 2.5 microns wavelength region, which is suitable for field use. High spectral resolution (more than 60 channels) is required. The instrumentation should be light weight and battery powered, it should have a sensing element that allows for easy pointing in any direction, and it should be able to store, manipulate, and display measured spectra. Moreover, communication with standard computers, PC's or workstations, should be straightforward. The system should operate in a wide variety of environmental conditions. The equipment is intended for measurements of the near-infrared spectral reflectances of landscape features during ground-truth campaigns for military captive flight tests and civilian remote sensing missions.

Phase I: a) Determine the feasibility of different sensors/sensorarrays to meet the above spectral standards, b) Develop a working "bread-board model" of the entire instrument package that will measure reflectance spectra as described above, and c) Develop and demonstrate appropriate calibration and validation methods to verify the performance of the "bread-board model."

Phase II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product to be a validated and calibrated prototype instrument, which will be used in field experiments to demonstrate the potential applications in this intended environment.

Potential Commercial Market: Valuable for research tool that has wide applications to various government agencies including Corps of Engineers, USGS, NASA, Forest Service amoung others. In addition this is a valuable tool for academic institutions.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-231 TITLE: Millimeter-Wave Backscatter from Cold Regions Terrain

CATEGORY: Engineering Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for measuring the millimeter-wave backscatter from Earth materials and landscape features in the field.

DESCRIPTION: Current millimeter-wave radar systems for measuring the backscatter and aborption characteristics of Earth surfaces are research prototypes, which are generally not well suited for the rigors of field portability and use. Very few of these systems are fully polarimetric. The reliability of these systems is also not substantial; usually one or two technicians are required for maintenance and repair during field missions. This project requires systematic application of knowledge about polarimetric radar systems, and integration of instrument packages with small computers to develop a dual frequency field-portable polarimetric FM/CW radar. Field operational equipment is required that will reliably, accurately, and rapidly measure backscatter in two frequency bands centered at 35 and 95 GHz. The radar should be designed to operate within a range of 5 - 50 m from the target, and the antenna/transceiver package should be light weight (less than about 100 kg). A data acquisition and instrument controller should be integrated with the instrument package. Moreover, communication with standard computers, PC's or workstations, should be straightforward. The system should operate in a wide variety of environmental conditions. The equipment is intended for measurements of the 35 and 95 GHz back scatter of landscape features during ground-truth campaigns for military captive flight tests, and for other special purpose investigations.

Phase I: a) Determine the feasibility of different transmitter/ receiver and controller systems to meet the above standards, b) Develop a working "bread-board model" of the entire instrument package that will measure radar backscatter as described above, and c) Develop and demonstrate appropriate calibration and validation methods to verify the performance of the "bread-board model."

Phase II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product to be a validated and calibrated prototype instrument, which will be used in field experiments to demonstrate the potential applications in this intended environment.

Potential Commercial Market: A valuable research tool that has wide applications to various government agencies including Corps of Engineers, USGS, NASA, Forest Service among others. This will also be a valuable tool for academic institutions.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-355 TITLE: High-Speed Vehicle Positioning and Reporting System

CATEGORY: Exploratory Development

OBJECTIVE: To develop an accurate and reliable system to determine the position of high speed ground vehicle such as high speed trains or MAGLEV and report the positions to a central control facility.

DESCRIPTION: Vehicles on the magnetically-levitated (MAGLEV) system to be developed in the United States will need an all-weather 24-hour positioning system for effective traffic management. The system must have meter-level accuracy and must transmit the real-time positioning, along with speed and direction of travel, once every second to a traffic control facility that may be over 100 miles away. The system must be operable in rural or urban areas.

Phase I: The contractor will develop a design for the stated positioning system. The design will include the proposed positioning technology (i.e. inertial, laser, GPS) that satisfies the above requirements and the communication system to transmit the positions. The design will include technical specifications, system components, operational constraints, and performance and cost estimates. The design will also include the communication system to report the position to a control facility, and will include an analyses of the effect of data processing and telemetry delays on the real-time accuracy.

Phase II: The contractor will build a prototype, if the system is not guideway-dependent, and install it on a car or truck for field tests. The system performance will be documented. Computer simulations and analyses may also be included.

Potential Commercial Market: Phase III potential is high, since such a positioning and reporting system could have application to other forms of transportation in which traffic management is essential. A successful implementation in a MAGLEV prototype could also lead to positioning and position data communications standards, where various modes of transportation; such as MAGLEV, aviation, and intelligent vehicle highway systems; could share a common system.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-358 TITLE: Mobile FAX Map Distribution System

CATEGORY: Exploratory Development

OBJECTIVE: To develop hardware and software to automatically request and distribute geographic data via mobile fax.

DESCRIPTION: The Mobile FAX Map Distribution System would allow a user 1) to telephone a request from a mobile fax for geographic data, 2) to execute the request on a remote computer, and 3) to receive the resulting map, chart, or text via fax.

Phase I: The contractor will deliver and demonstrate a capability to perform all the required processes, ie. request data mobile fax, extract data from a geographic information system and create a map display, and receive data via mobile fax. The demonstration shall be done in a completely automated fashion once the request is made via fax.

Phase II: The contractor will enhance the basic capabilities to refine the user interface and improve performance of the system. The contractor will deliver a rugged prototype system and demonstrate the system in an Army field exercise.

Potential Commercial Market: The fax map distribution system would enjoy great success in the commercial marketplace. Applications would include disaster relief, police and fire services, utilities, delivery services, commuter information services, and business travel.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-359 TITLE: Feasibility Study to Determine the Ability to Use an In-situ Vitrification Tent to Contain Open Burning Gases

CATEGORY: Basic Research

OBJECTIVE: To control open burning emissions.

DESCRIPTION: The Army uses open burning to treat waste explosives and propellants. This practice is becoming more regulated and may be banned in the future. Open burning is a very inexpensive method of treatment. If we can convince the EPA of the effectiveness of the tent then we could continue to use open burning and not have to use a more expensive technology such as incineration.

Phase I: Perform an engineering study to determine the feasibility of using such a tent. If feasible prepare a system design to be used in pilot testing.

Phase II: Test the system designed in phase I to include emissions testing.

Potential Commercial Market: The commercial market would be limited to those concerns that can plan open burning of any material. This system could be used during fire extinguisher training. This project uses a current commercial market item used in In Situ Vitrification. This project uses a current commercial market item used in In Situ Vitrification. Improvements made to this device for Army use would enhance its use in the commercial field.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-360 TITLE: Alternative Solvents for Asphalt Cement Extractions

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods and procedures for the use of alternative solvents (pine or citrus based) for asphalt cement extraction and recovery.

DESCRIPTION: The solvents currently used include: trichloroethylene, trichloroethane, and methylene chloride. These are considered hazardous materials and require careful handling and controlled disposal. The test methods and procedures developed for the alternative solvents should involve the use of standard extracting devices currently specified in ASTM D 2172. Detailed procedures such as those currently outlined in the ASTM standard should be developed. A series of extractions shall be performed using these procedures and the results compared to those obtained using the existing solvents and test methods. Investigate possible methods of recovering the asphalt extracted by the use of alternative solvents to insure that the properties of the recovered asphalt are not affected by the solvent.

Phase I: Evaluation of available solvents to identify those most promising. Factors to consider include: ease of handling (safety considerations), solvent effectiveness, cost, disposal requirements, recyclability and ability for adaptation to existing equipment. At the end of this preliminary evaluation, an initial series of tests should be conducted to evaluate the effectiveness of the solvents for asphalt cement extraction. Then run preliminary tests to investigate the viability of recovering the asphalt cement extracted with these alternative solvents.

Phase II: Finalize the details of the refined or developed test procedures for the extraction of the asphalt cement and establish reliability and repeatability in regards to variations encountered between different technicians and laboratories. If suitable test methods and procedures for recovering the asphalt cement can be developed, finalize the details and establish reliability and repeatability as in the extraction test.

Potential Commercial Market: The utilization of alternative (non-hazardous) solvents for asphalt cement extraction and recovery will eliminate the need for chloroflourocarbon (CFC) solvents currently in use. These CFC;s are hazardous materials and require care in handling and controlled disposal and they have been linked to depletion of the ozone layer in the atmosphere. The development of alternative solvents will provide an answer to these environmental concerns.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-361 TITLE: Site Characterization and Analysis Penetrometer System

CATEGORY: Exploratory Development

OBJECTIVE: Develop materials and mechanical components to support a new environmental sensing system.

DESCRIPTION: A number of sensors are being evaluated for use in a Site Characterization and Analysis Penetrometer System (SCAPS). These sensors will give SCAPS the capability to map the presence and concentration of various subsurface contaminants at depths ranging from 0 to 150 feet. These electrical, electromagnetic, optical, and chemical sensors require cables or tubing to transmit and collect energy and/or samples from the cone penetrometer system. Research is needed in order to define materials for electrical and fiber optic cables, as well as to design and construct mechanical systems for feeding and retrieving the cables and tubes.

Phase I: Evaluate available materials and mechanical systems, recommend possible designs for incorporation into SCAPS. After review by the Army sponsor, prepare a detailed design and assemble prototype equipment for a limited laboratory test.

Phase II: Fabricate a fieldable prototype system for testing as part of SCAPS. A number of controlled experiments as well as field tests at contaminated sites will be conducted. Based on the results of these tests, the prototype system will be modified as required to achieve required performance, and a minimum of four complete systems will be supplied to the sponsor for follow-on testing.

Potential Commercial Market: There is considerable interest in developing fiber optic materials that can efficiently transmit energy in the thermal-IR band. In addition, there are commercial applications for electrical cables for microwave/millimeter wave applications that can be made insensitive to bending during installation and operation.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-362 TITLE: Controlled Camouflage Systems fo Advanced Land Combat Applications

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-363 TITLE: Radar Antenna Optimization

CATEGORY: Exploratory Development

OBJECTIVE: Define the antenna requirements of a low-frequency (50 MHz to 1 GHz) radar system for detecting plastic and metal anti-tank mines that are buried in specific soil types and conditions.

DESCRIPTION: The Army is currently involved in the measurement and modeling of electromagnetic energy propagation through soils. One of the products of this effort is a database of complex dielectric properties of specific soil/moisture/temperature combinations. The requirement of the work described in this solicitation consists of initially analyzing the complex dielectric properties of a specific soil type/moisture/temperature combination, and of a limited number of anti-tank mine surrogates. The results of this analysis are then to be applied to design and fabricate a single-antenna that maximizes the probability of detecting the mines at burial depths ranging from 2 to 15 cm.

Phase I: Define the bounds on the electromagnetic conditions presented to a vehicle-mounted radar by various metallic and non-metallic anti-tank mines buried in well-defined soil conditions. Based on the results of this study, develop a preliminary design (operating frequency, polarization, signal-to-noise- requirements, etc.) of an optimized prototype antenna. A design review will be conducted with the Army sponsor prior to proceeding with a detailed design of a single-element antenna for detecting buried mines in a limited range of soil conditions.

Phase II: Fabricate the antenna designed during Phase I, integrate it into an FM-CW vector network analyzer based system, and perform a series of controlled laboratory experiments to demonstrate detection performance in a milited range of soil conditions.

Potential Commercial Market: Locating underground utilities, clearing hazardous and formerly used Defense sites, and various geophysical mapping applications.

A-10 ENGINEERING SCIENCES (I.E. ROBOTICS, DYNAMICS, STRUCTURES, MECHANICS AND CONSTRUCTION)

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-038 TITLE: Intelligent Sensor Based Robotic Control System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems for ammunition handling, resupply and logistics applications.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor based servo control systems for high performance robotic manipulators. Specifically, a high speed 386 based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control

strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to deal with fundamental problems of mobility and base motion effect, flexible task level control, multi-sensor integration, dual arm coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunition to and from resupply vehicle and loading ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control, voice natural language interface for control, dual arm control strategies, world modeling design environment, real time, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/avoidance and component based software architectures.

Phase I: Develop methodology and algorithmic approaches to intelligent sensor based robotic control systems for applications to materiel handling and loading. Perform preliminary modeling and simulation studies to determine performance/robustness characteristics of the control laws and algorithms, real time processing requirements and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

Phase II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

Potential Commercial Market: The technology developed under this program can be utilized on any production line performing product handling, part mating and product transferring applications. Particularly, for the Army, this technology can be used in programs like FARV-A and AFAS to perform ammunition fusing, handling and loading during re-supply operations.

OSCR: This technology will provide cost reductions to Army operations where elimination of operators is needed. For instance, in programs like FARV-A and AFAS, this technology will be beneficial due to its potential application to operations such as fusing, de-palletizing and transferring of ammunition to and from a re-supply vehicle.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-040 TITLE: Micro-Mechanically Steerable Optical/IR Scanner

CATEGORY: Exploratory Development

OBJECTIVE: The conceptual design, prototype fabrication and demonstration of a micro-mechanical optical/IR scanner for precision munitions and commercial imaging application.

DESCRIPTION: Because most IR/optical seekers and sensors have relatively narrow instantaneous fields of view, it is usually necessary to provide scanning of some sort in order to search a large field or to point the sensor in any desired direction. Usually, this is accomplished with the use of mechanical gimbal contrivances. The ability to ultimately achieve strap-down seekers with no macro-size moving parts would be of considerable interest. Solid state or micro-device optical concepts which can provide dynamic and agile control over the instantaneous line of sight of a seeker with no macro-size moving parts are of interest in order to solve this problem. The concept must lend itself to lightweight, rugged, mass producible, and low cost objectives. The detector being scanned can range from a single detector, small linear array, or a full 2D imaging focal plane array. Examples of methods which can combine micro-device, principles with optical scanning are: mosaic reflecting or refracting optics with individually controllable optical properties, geometry, focal length, index of refractions, aperture, aspheric shape, etc. Micro Fresnel lenses, mirrors, gratings, holograms, binary optics, deformable devices etc., are further examples provided that they can be micro-controlled based on microdevice principles. The following are the desired program goals:

* Scan Angle: + 30 degrees
* Scan Rate: 500 to 12,000 deg/sec
* 4 in. Aperture, volume downsizable to 12 in.3
* Number of parallel channels: 1-10
* Applicable IR band: 0.7 to 10 microns
* Typical power level of the beam which the optical/IR scanner should be capable of handling without degradation range from minuscule for passive scanners up to 20 watts for scanning ladar.
* The scanning system including packaging should be "G" hardenable to 20,000 g's.
* The system should be capable of operation throughout the military temperature range of -50 to +140 degrees F.

Phase I: The contractor will perform a detailed scientific and engineering analysis including, but not limited to, computer simulations and analytical analysis to develop a feasible concept of an optical/IR micro mechanical scanning mechanism compatible with the design goals specified above.

Phase II: The contractor will fabricate a breadboard prototype configuration of the optical/IR scanning mechanism specified in the Phase I design and will demonstrate the operation of the system design.

Potential Commercial Market: If successfully developed this product is potentially capable of providing low cost, mechanically rugged and agile sensing systems for: commercial satellites, aircraft and terrestrial terrain mapping, thermal imaging systems, security surveillance and optical display technology compatible with current and future liquid crystal display technology.

OSCR: Cost Reduction Drivers: 1. Replacement of high cost labor-intensive precision mechanical assembly with a lower cost mass produced solid state electronic micro-device system. 2. Increased compatibility with the "wooden round" concept by increasing storage reliability and eliminating the need for costly periodic maintenance and inspection. 3. Reduced power consumption due to use of solid state electronic components. 4. Reduced packaging volume obtained by replacing bulky mechanical components with miniature solid state de state devices.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-041 TITLE: Azimuth Orienting Device for Towed Artillery and Mortars

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an azimuth orienting device for light indirect fire weapons such as towed howitzers and mortars with the required characteristics of accuracy, response time, ruggedness, low power requirement and portability. This device would apply to a broad segment of ARDEC systems in the fire support commodity area. There are also potential future commercial applications in survey technology and mapping.

DESCRIPTION: A requirement exists for an azimuth orienting device for towed artillery and mortar fire control systems. Current techniques for these types of indirect fire weapon systems require the establishment of an azimuth orientation line by survey techniques employed by a survey party. It is desired that towed artillery weapons, self-propelled mortars and ground mortars be equipped with an autonomous capability to establish laying azimuth referenced to grid north. Available orienting systems which are used on some self-propelled artillery weapons are based on internal navigation system technology and are too large and heavy, too costly, and impose an unacceptable power requirement for use on the weapon systems envisioned. The characteristics required of the device are: accuracy of azimuth determination +/- 1 artillery mil RMS; time to determine azimuth no greater than 2 min with options for less time with reduced accuracy at operator selection; output either in true or grid azimuth; power requirements minimized with provision for integral battery and 24 v military vehicle power input; sufficiently rugged to withstand the maximum firing shock on a 155mm towed howitzer (can be in a standby or off mode during firing); provision for verification of boresight, i.e., alignment with the center line of the weapon bore when mounted on the weapon; output available for visual reading by the operator and as a digital signal for input into a fire control computer. The device should minimize, in so far as possible, size and weight so as to allow portability for light weapon systems. Production cost is also a design consideration so that the device can be afforded in sufficient quantity to equip each towed howitzer and heavy and medium mortar with the device.

Phase I: Develop the design concept of the azimuth orienting device. Produce two broad board type proof of concept units, one to be applied to towed howitzers and one for mortar systems. Develop preliminary functional specifications based on results of laboratory and field testing of the units.

Phase II: Produce sufficient follow-on units based on the preliminary functional specifications from Phase I to fully evaluate the technical and functional characteristics of the concept in an operational environment. Support both technical and user testing of the units. Develop finalized functional specifications.

Potential Commercial Market: This system would have direct application in the engineering survey and mapping technology areas. It would apply to a number of similar commercial applications where an accurate directional reference with respect to north is required.

OSCR: The operational concepts of indirect fire control that would be permitted with fire control systems based on this subsystem would allow the reduction of the reliance on survey capability to orient artillery and mortar weapons in the field. When each howitzer or mortar is provided with its own capability to accurately orient itself with grid north, then the very expensive, labor and training intensive survey requirement can be significantly reduced. This should result in a substantial operations and supportability cost reduction in that equipment, personnel and vehicles are reduced.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-043 TITLE: Advanced Adaptive Weapon Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate low cost high performance digital servo control technology for precision fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital control design techniques and LQG LTR design approaches. Further improvements in gun accuracy are anticipated through the development of improved robust nonlinear and adaptive control laws and control laws that exploit recent advances in H infinity and II technology permits these techniques to be implemented in high bandwidth digital servo loops required for precision gun stabilization. This project will address the broad spectrum of issues associated with the development of design tools and methodology, modeling, simulation and real time hardware/software implementation.

Phase I: Develop methodology for design and implementation of high performance robust adaptive and nonlinear control laws for precision weapon stabilization and tracking. Formulate specific control laws for nominal two input, multi output nonlinear plant with friction, backlash, resonant modes, high impulse periodic disturbances nonlinear compliance and sensor noise. Determine performance and robustness characteristics with respect to structural and unstructured plant perturbations and provide analysis of hardware/software implementation requirements.

Phase II: Develop a fully integrated design, test and prototyping environment for advanced nonlinear and adaptive multivariable control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

Potential Commercial Market: This work has a very high probability of being commercialized. The methodology and design environment developed in this SBIR can be used by many industries such as hydraulic and electric motor manufacturers, machine tool manufactures, process control companies, automobile and aircraft companies, robotic applications, stabilized optical sight systems, etc. Anyone who designs control systems must confront nonlinearities, parameter variations, backlash, friction and resonant modes.

OSCR: Microprocessor-based control is a low-cost platform independent way to implement advanced control algorithms. One of it's biggest benefits is the ability to rapidly modify the control algorithms, making it very cost effective when upgrading a weapon platform or even moving the entire system to a new application. Nearly all of the current controllers in the Army are analog based; i.e. capacitors, op amps and resistors fixed to a circuit card. Changes are very hard to make and portability between weapon platforms is impossible. If one microprocessor could be used for each servo control application in the Army with only the code being modified, the cost savings could be large. Another cost saving aspect of this work is the ability to get very high performance out of systems with backlash, friction, resonant modes, etc. What this means is that the Army can use a low-cost microprocessor-based Adaptive-Nonlinear Controller rather than buying new, very precise (and expensive) mechanical hardware or retrofitting existing systems to eliminate the nonlinearities, i.e. improve the performance with better algorithms and software rather than hardware.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-045 TITLE: Simulation of Optical Surface Errors Resulting from Manufacturing Processes

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate software for simulating errors in optical surface generation produced by the Opticam Spherical Module (SM) as a result of machine misalignments and integrate into SM in-process correction.

DESCRIPTION: As a result of the MANTECH optics program with the Center for Optics Manufacturing, generation of spherical surfaces via deterministic tubular tool grinding has been demonstrated. These surfaces have surface figure better than one wave, RMS surface roughness less than 100 Angstroms, and subsurface damage less than two microns. The Computer Integrated Manufacturing (CIM) capability of the Opticam SM machine can now be enhanced via software to predict surface manufacturing errors given machine positioning and alignment tolerances. In the Optical Design Phase, this would be used to predict optical performance of manufactured parts and aid in cost effective designs. In the manufacturing phase, this software would aid in closed loop control of the Opticam SM. Interferograms of manufactured optics would be compared to the desired surface shape to diagnose machine misalignments and yield automatic correction or operator intervention, if necessary. Phase III Objectives: The results of this effort will be incorporated into the MANTECH Optics Thrust Program at the Center for Optics Manufacturing (COM) in Rochester, N.Y. MANTECH programs are planned to be performed at the center for FY93 to FY97. The program resulting from this SBIR would become part of the Opticam (Optics Automation & Management) system software and be implemented in continuing technology transfer at the COM, a consortium of academe and the US optics

manufacturing industry. This would be as part of an ongoing IMIP program. This technology would advance process control for optics manufacturing and optical design tolerancing.

Phase I: Develop and demonstrate software for predicting shape of optical surfaces resulting from misalignment errors in the Opticam SM. Formulate concept for interface of predictive software to commercially available optical design packages. Formulate concept for interface of predictive software with metrology equipment and the Opticam SM controller for closed loop operation of the machine.

Phase II: Develop an interface for the predictive software compatible with commercially available optical design packages. This might take the form of a standardized format ASCII file which the developers of Optical Design Software can use. Develop and demonstrate interfacing the software with the Opticam SM to perform closed loop operation.

Potential Commercial Market: Opticam machines are already commercialized and being sold. It is very likely that the contractor or an optical design software provider will commercialize this software as a module which can interface with Opticam. All Opticam-related projects are directed toward dual-use commercialization for the US optics manufacturing industry.

OSCR Qualifications: This software would probably lead to a cost improvement in making lenses of approximately five percent. Approximately $100M in precision optical components are ordered by the government every year.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-051 TITLE: Automated Vision Inspection of Threaded Weapon Components

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced automated vision inspection system technology for characterization of threaded weapon surfaces.

DESCRIPTION: Develop and demonstrate advanced automated vision system/technology for inspecting threaded ordnance surfaces. There is an Army-wide need to improve the method by which threaded parts are tested. Recent legislation enacted through the Fastener Quality Act, and class 3 safety-critical fasteners, calls for quantitative thread measurement versus quantitative thread gauging. Many of the required inspection parameters cannot be adequately characterized by traditional mechanical gauging methods in use today, especially at the high inspection rates required by 100% inspection and SPC. Measurements of internal threads are particularly difficult because of the mechanical and visual access problems. The accurate dimensional characterization of internal surfaces that contain critical features, such as threads, bearing shoulders, and seal surfaces, has always been a major concern to the U.S. military, their manufacturing representatives, and their QA/QC representatives. This is especially true where functional failure of the part affects the safety or effectiveness of critical machinery used in weapon systems.

Phase I: Design, build, test and demonstrate a proof-of-concept laser-based testing system that is capable of providing a dimensional characterization of internal and external threaded surfaces.

Phase II: The objective will be the development of a full-scale prototype system that is lightweight, portable, and rugged. The device would be extendible to a wide variety of thread inspection applications both in the machine shop and in QC/QA laboratories.

Potential Commercial Market: The proposed thread inspection technology will find immediate application in a large variety of tasks where nondestructive, high accuracy dimensional characterization of complex surfaces are required. The proposed apparatus will be used in laboratory engineering studies, industrial control, and manufacturing process monitoring and control. The "system" to be designed will provide measurement capabilities mandated by law and often referred to in cited MILSPEC documentation, and which cannot be accurately obtained by other conventional measurement schemes. In addition to the compliance issues, immediate application of the measurement system for thread inspection alone is expected to decrease overall manufacturing costs, increase fastener performance, and decrease maintenance costs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-052 TITLE: Soldier Weapons Improvement by Development of an EMAT (Electromagnetic Acoustic Transmission) System for Non-Destructive Inspection of Cannon Tubes

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the use of EMAT to detect flaws in cannon preforms and forgings.

DESCRIPTION: An EMAT system has recently been developed which is capable of measuring steel thickness up to 6 inches. EMAT has the potential to be used to detect flaws in steel, but further technology development will be required to address certain problems associated with flaw detection. Among these are: (a) Development of an effective means of differentiating flaw and noise signals, (b) Optimize the system sensitivity in order to enable detection of small cracks and inclusions.

Phase I: Develop the concept for the system and the methodology to be used to detect flaws in cannon preforms and forgings. Test the system concept on sample material and on actual preforms and forgings.

Phase II: Develop an inspection system capable of flaw detection in forging preforms and in the rough forgings. Provide a report describing the development work and the system.

Potential Commercial Market: In numerous commercial applications, ultrasonics are used as a means of inspecting material for flaws. Conventional methods of generating an ultrasonic wave within a material are limited by the need to be physically coupled by either a solid or liquid bond. The ability to produce an ultrasonic wave without physical contact offers a number of advantages, including reduced inspection time, the ability to operate in remote and inaccessible locations, reduced transducer wear, and the ability to operate at elevated temperatures.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-060 TITLE: Automation Friendly Fuze Packaging

CATEGORY: Exploratory Development

OBJECTIVE: To Develop automation-friendly fuze packaging for use with the autoloader technology of future artillery cannon and resupply systems such as AFAS and FARV-A.

DESCRIPTION: Future artillery and cannon resupply vehicles will feature an increased reliance on the automated handling of artillery components. While much work has been done in the areas of autohandling of the projectiles and propellant, little has been done with respect to fuzes. The current packaging for artillery fuzes requires manual access and handling of individual fuzes. A need exists to explore new packaging designs that lend themselves to automation. The result will be direct manpower savings, a decrease in resupply time and a reduction in ammunition logistics costs.

Phase I: The contractor shall analyze established robotic artillery autoloader technology in order to develop container design concepts. A minimum of 2 designs shall be proposed that are consistent with current, state-of-the-art autoloader technology. At the end of Phase I the contractor shall deliver a report that includes an analysis of the autoloader technology and recommends a minimum of two container configurations.

Phase II: Container designs shall be either physically prototyped and/or modeled using computer simulation technology in order to demonstrate their use in the artillery autoloader mechanism. Modifications to the design shall be made as necessary to ensure successful performance of the automated package/autoloader interface. The contractor shall recommend an optimal container configuration for manufacture. If the designs are physically prototyped the contractor shall deliver 10 containers of an agreed-upon design to the U.S. Government for testing purposes. If the designs are modeled with computer simulation technology the contractor shall deliver 3 disk copies, each containing the proposed container design and components, and an animated computer simulation of the interface and functioning of the container in the autohandler mechanism. The contractor shall also deliver a final report detailing the work done in Phase II.

Potential Commercial Market: The technology developed by this study may benefit any industrial process in which components of assembly must be removed from a shipping or storage container and introduced into an automated system. This includes the manufacture of virtually any medium and large size equipment such as automobiles, trucks, appliances, machinery, etc.

OSCR: Automation friendly packaging will allow faster and safer production of the end item. By considering automation interface in the design of the packaging, problems associated with interfacing may be reduced or eliminated. Operating and support cost savings with respect to associated labor, safety, operating efficiency, and waste disposal may be realized.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-067 TITLE: Non Destructive Inspection By Infrared Imaging Spectroscopy

CATEGORY: Advanced Development

OBJECTIVE: Develop, build and test a prototype multi-spectral infrared imaging detector system for non-destructive inspection.

DESCRIPTION: Non-destructive inspection (NDI) techniques using infrared can be categorized into two broad areas: detection of material composition from the infrared signature and detection of part or defect geometry from thermal imaging. The former involves measuring the intensity of the spectral components and the lagger involves measuring the energy distribution over a surface. Advances in the technology make it possible to measure the energy distribution of multiple spectral elements over a surface (infrared imaging spectroscopy). This technology is used to determine geological compositional differences. This solicitation is for the development and application of infrared imaging spectroscopy to the field of NDI.

Phase I: The contractor shall demonstrate multiple practical NDI applications for multi-spectral infrared imaging on a laboratory scale. The contractor shall design a prototype industrial grade multi-spectral automated infrared imaging system with broad and significant NDI applications to the military. The contractor shall find potential sources of venture capital for developing the 'SBIR Phase III' market.

Phase II: The contractor shall build and deliver the prototype system designed in Phase I, test it, document its operational characteristics, validate its worth with real NDI applications, and design a production version.

Potential Commercial Market: Commercial and military applications are bountiful. The results will augment our work in data fusion of NDI signals. Applications include imaging variations in material composition of composites, ceramics, plastics, propellants, and gases. Army specific applications range from inspection of printed circuit boards in various munition items for delamination and good solder joints, to determination of contents of foreign unexploded rounds, to bench testing of rocket motor delay assemblies. Three dimensional imaging applications are possible if the sensors are configured for thermal tomography.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-090 TITLE: Microscale Sensors and Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabricate, and test microelectromechanical (MEM) devices for use as microscale sensors and actuators in military and civilian applications.

DESCRIPTION: General - The U.S. Army has identified the need for miniature, low cost, and reliable sensors and actuators for use in tactical military equipment. Recent developments in micromachining technology have made it feasible to design and fabricate microelectromechanical systems using standard semiconductor integrated circuit processing techniques. These microscale sensors/actuators offer significant reductions in the size, cost, and power requirements of conventional sensors/actuators while providing the desired capabilities to the soldier on the battlefield. Collaboration with EPSD and use of EPSD microfabrication facilities for device development are possible. Examples of specific devices of interest are high "g" gyroscopes for smart munitions guidance systems, vibrational sensors for failure prognosis of ground and airborne structures and propulsion systems.

Phase I: Phase I will identify the type of sensor/actuator device to be fabricated and the intended military application. A device design and theory of operation will be presented. Demonstration of the device processing steps required for fabrication must be detailed. A structurally complete prototype device will be fabricated to determine the feasibility of the design and process integration.

Phase II: Phase II will encompass device design and process refinements. Initial device testing should demonstrate the operation of the device. Data must support the concept of operation for use in military environments. Complete fabricated devices will be delivered to conduct initial testing for use in military systems.

Potential Commercial Market: Applications for microelectromechanical sensors and actuators cover both military and commercial systems in areas such as munition guidance systems, failure prognosis of vehicular structures and propulsion systems, automated control and navigation of ground and airborne vehicles, hazardous chemical/biological materials warning and identification, robotic positioning systems, medical drug monitoring, micro surgery, and medical diagnosis sensors.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-151 TITLE: Helicopter Rotor Blade Trailing Edge Control Surface

CATEGORY: Exploratory Development

OBJECTIVE: Develop practical design concept for controlling deflection of a helicopter rotor blade trailing edge control surface.

DESCRIPTION: Rotor blades of modern production helicopters are controlled by changing the pitch of the entire blade at the blade root pitch bearing. Such blades typically do not contain movable trailing edge control surfaces. However, new opportunities for providing flight control and reducing vibratory loads will be possible if a practical capability for controlling the rotor blade trailing edge can be developed. This may be a discrete flap segment or an integral flexible segment of the trailing edge. One approach currently receiving attention is to apply exotic smart materials such as piezoelectric, magnetostrictive, or shape memory alloys. The present topic is specifically addressed toward more conventional approaches, based on exploiting recent technology advances to tailor electromechanical or related devices to the unique requirements of helicopter rotor blades. Such approaches will require small, light weight, efficient, highly reliable, rugged, and rapid response actuation devices for incorporation within the rotor blade airfoil structure. These requirements mitigate against conventional electro-hydraulic actuators, reduction-geared electric motors, and conventional mechanical components such as hinges, bearings, and pushrods to move the trailing edge control surface.

Phase I: Develop and analyze candidate concepts for trailing edge control devices. Evaluate physical and performance characteristics. Select optimum approaches.

Phase II: Carry out engineering design of candidate control device, fabricate and bench test prototype system on a typical rotor blade structure.

Potential Commercial Market: This technology is applicable to commercial helicopters as well as military.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-152 TITLE: Damperless Helicopter Rotor Blade

CATEGORY: Exploratory Development

OBJECTIVE: Develop helicopter rotor blade concepts that do not require hinges, bearings, or lead-lag dampers.

DESCRIPTION: Reliability, cost, and performance of helicopters are all improved by advanced rotor systems having fewer parts, especially hinges, bearings, and lead-lag dampers. These components require maintenance, lubrication, and in the event of failure may result in instability or failure of the rotor system. Recent advances in rotor technology have produced bearingless rotor systems that no longer contain blade motion hinges and bearings, but these rotors still retain lead-lag dampers to suppress potential air and ground resonance of soft inplane configurations. Aeroelastic couplings hold the potential to tailor aerodynamic and structural properties to provide inherent stability without need for auxiliary lead-lag dampers.

Phase I: Use analytical methods to identify design concepts and approaches based on optimal aeroelastic and structural design that satisfy air and ground resonance stability requirements.

Phase II: Confirm design concepts by conducting small-scale model rotor testing.

Potential Commercial Market: This technology would have direct application to the commercial rotorcraft market. Commercial benefits include improved affordability through reduced development and operating costs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-153 TITLE: Helicopter Rotor Blade One/Rev Vibration Reduction

CATEGORY: Exploratory Development

OBJECTIVE: Identify methods and techniques for reducing helicopter rotor one/rev vibration.

DESCRIPTION: One component of helicopter vibration is produced by non-identical mass and aerodynamic properties of the rotor blades. These variations between blades result in helicopter vibrations at a frequency equal to the rotational frequency of the rotor. Current techniques for minimizing such vibrations are to minimize blade-to- blade mass imbalance and to maintain quality control of blade aerodynamic contours in the manufacturing process. Innovative research and development may identify additional complementary approaches to reduce this component of helicopter vibration.

Phase I: Explore concepts and conduct analysis of potential candidates to identify and assess effectiveness.

Phase II: Implement engineering approaches, including possible hardware development, and conduct appropriate model or full-scale tests.

Potential Commercial Market: Vibration reduction improves both ride quality as well as reliability. There is direct application to the civil rotorcraft market.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-154 TITLE: Composite Rotor Blade Sectional Analysis

CATEGORY: Basic Research

OBJECTIVE: To develop a computational tool which can decrease analysis costs by determining equivalent beam properties for three-dimensional composite rotor blades.

DESCRIPTION: Sophisticated comprehensive analyses of helicopter aerodynamics and structural dynamics phenomena that are beginning to be available have the potential to revolutionize the design process and significantly improve the performance of Army rotary wing aircraft. However, detailed modeling of nonlinear anisotropic rotor blades places an increasing burden on the analyst to prepare input data. The finite element analysis of a composite rotor blade structure would normally require costly three-dimensional methods. However, orders of magnitude less expensive beam methods can be used by first performing sectional analysis to determine beam properties. The sectional analysis of a complicated beam-like rotor blade need only be done once if the blade is spanwise uniform, or only a few times to accommodate typical mild spanwise nonuniformity. Sectional analysis is a two-dimensional problem, the domain of which is a local cross section. The sectional characteristics of a closed cross-section beam are in the form of a symmetric six-by-six stiffness matrix. The sectional analysis also provides a set of displacement and strain influence matrices which, when multiplied by beam strain measures, yield warping displacement and strain over the cross section, yielding an approximation to the three-dimensional solution.

Phase I: Prepare a research code to provide sectional analysis including the recently enhanced theory which incorporates initial twist and curvature. Demonstrate functioning of the code on a suite of test cases.

Phase II: Develop a production level code including a graphical pre-processor providing on-screen view of the cross section coupled with CAD capabilities and with a mesh generator (also viewed on screen), a graphical post-processor providing graphical representation of stress and strain at selected axial positions (as determined in the beam theory solution).

Potential Commercial Market: This technology is applicable to the design of commercial helicopters as well as military helicopters.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-158 TITLE: Electronically Survivable Composite Airframe Primary Structures

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate innovative organic composite primary (flight load carrying) structural concepts that satisfy a variety of electrical and electronic threats and design constraints, without imposing unreasonable acquisition, operational or support costs.

DESCRIPTION: Because of exceptional strength to weight performance and certain producibility characteristics, advanced composite materials will be used almost exclusively for the primary structure of the Army's next generation/future systems (NG/FS) air vehicles. Although carbon and graphite fibers have some electrically conductive properties, advanced composite structures can be characterized as empirically non-conductive in the lightning strike, high-frequency, and some other radio frequency environments. Graphite composites can be considered conductive in the ultrahigh and radar frequency ranges. Prior research and development programs have demonstrated that composite structures may inherently provide sufficient electrical shielding and conductivity to satisfy certain avionic shielding and detectability constraints, but require additional metalization or dielectric treatment to provide adequate antenna ground planes, lighting strike protection, or stealth levels. These often conflicting design solutions add considerable weight, manufacturing difficulty and cost to the system.

Phase I: Investigate the current and projected performance requirements and integrated system design solutions for advanced composite airframe structures in the future electrical/electronic environment. Characterize the tradeoffs and penalties in the designs in terms of cost, producibility, weight, strength, and electrical performance for the various solutions. Develop and evaluate innovative design solutions to satisfy the future operational requirements with emphasis on reducing weight and cost impact to primary NG/FS air vehicle structures.

Phase II: Using innovative material system design and processing techniques, fabricate and evaluate through test candidate coupon and test panel structures that would satisfy the requirements identified in phase I. Select and further develop the most promising primary structural concepts for demonstration in generic airframe subsystem components. Evaluate these components in terms of weight and cost, and structural and electrical performance.

Potential Commercial Market: Lightning strike protection, avionic and electrical system shielding and grounding, and antenna performance are all additional cost drivers for composite airframe designs. This technology will enhance use of composite materials in civilian airframes.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-169 TITLE: Remotely Piloted Rotorcraft for Cargo Delivery

CATEGORY: Exploratory Development

OBJECTIVE: Define a required aircraft subsystem to accomplish a remotely piloted rotorcraft cargo delivery mission.

DESCRIPTION: Define the Mission Equipment Package (MEP) and aircraft control systems required to allow a remotely piloted rotorcraft to deliver cargo in a warfighting environment. The rotorcraft systems must be able to handle such unexpected eventualities as terrain, obstacles and threats and still reach destination. The MEP will require systems to provide obstacle avoidance, position/location of aircraft, route planning communication/navigation, threat warning, etc. to accomplish the mission.

Phase I: The objective of Phase I is to define the required sensors and aircraft subsystems to allow a rotorcraft to be operated remotely to travel to a designated position, land/deliver cargo, and return to a designated position. Decision aiding or expert systems may also be required. The mission would cover day and night operations throughout the entire battlefield.

Phase II: The objective of Phase II is to define the required sensors and aircraft subsystems to allow a rotorcraft to autonomously perform the cargo delivery mission of Phase I.

Potential Commercial Market: The results of Phase II could be applied to commercial delivery systems, within warehouses or possibly within town/cities.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-175 TITLE: Helicopter Weapons Deployability, Operability, and Supportability

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-178 TITLE: Affordable Technology for Magnetic Signature Duplication

CATEGORY: Advanced Development

OBJECTIVE: To develop affordable technologies for defeating magnetic fuzed mines to support a Milestone II decision.

DESCRIPTION: Magnetic-Influence-Fized (MIF) landmines are in the inventory of many nations throughout the world and have become a significant threat to maneuver forces. These mines target the magnetic signature of vehicles allowing precision full vehicle-width attack. The Vehicle Magnetic Signature Duplicator (VEMASID) system was designed to defeat these mines by projecting a magnetic signature ahead of the vehicle. VEMASID was Type Classified for Low Rate Production in Feb 91; however, the user subsequently decided that the cost of the system was too high and terminated the program. The intent of this effort is to demonstrate more affordable techniques and technologies to protect vehicles from MIF mines using magnetic signature duplication. The system will be required to actuate at least 95% of MIF mines in a path 1.2 times the width of the vehicle in the battlefield operational environment. The requirements of the VEMASID ROC (Required Operational Capability), 19 Feb 86, apply. The ability to defeat multi-axis magnetic influence fuzes is desired.

Phase I: This effort would result in a brassboard system suitable for testing on an M109 Howitzer and data sufficient to support a conclusion that the system could be made affordably.

Phase II: This would extend the development to fabricate engineering prototypes for environmental, reliability and performance testing and to more fully develop affordability data.

Potential Commercial Market: Phase III would encompass preparation of program documentation for presentation to the PM for Mines, Countermine and Demolitions and to TRADOC in support of Milestone decisions leading to production and fielding. This effort addresses S&T Thrust in Advanced Land Combat and the Star 21 focal values for affordability and casualty reduction.

OSCR: 1 & 4 Field Diagnostics/Prognostics. Predict a failure before it happens, thus preventing premature failure and unnecessary maintenance actions. Power saving technologies that can reduce overall power usage and improved battery systems.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-181 TITLE: Diesel and JP-8 Homogeneous Mixture Fueled Rotary Engine

CATEGORY: Advanced Development

OBJECTIVE: Develop Diesel and JP-8 homogeneous mixture fueled rotary engines.

DESCRIPTION: The Army needs light-weight, quiet and high power/weight ratio Diesel and JP-8 fueled engines.

Phase I: Develop the necessary design changes and predict the diesel fueled engine performance based on combustion analysis and the gasoline engine manufacturer's published data. Demonstrate the predicted performance with breadboard testing.

Phase II: Fabricate two prototypes of the diesel/JP fueled hardware using production gasoline rotary engine cores.

Potential Commercial Market: The diesel rotary could be used in any of the gasoline applications where the weight, size and vibrations of the reciprocating Diesel engines of comparable powers are prohibitive. This effort addresses S&T Thrusts in advanced land combat and the Star 21 focal values for electric drive technology.

OSCR: #6 Technologies which significantly reduce fuel consumption (e.g. new engines, reduced vehicle weights, improved fuel/lubricants, new vehicle types (electric drive)) or improved fuel distribution is important to this topic.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-213 TITLE: Programmable Logic Controller Energy Management Programs

CATEGORY: Exploratory Development

OBJECTIVE: Develop application programs for Programmable Logic Controllers related to energy management.

DESCRIPTION: Programmable Logic Controllers (PLCs) have been proven by USACERL in the laboratory to have the capability to be used in a cost effective way to control Heating, Ventilating, and Air Conditioning (HVAC) processes. There do not exist however any application programs for energy management functions such as demand limiting, night setback, and optimum start stop. PLCs have many advantages over current HVAC control hardware, but will not be considered for Army wide use until the capability to perform energy management functions is proven. The use of such devices would greatly impact creature comfort and operating/support cost reduction.

Phase I: Determine at what level in a networked system of PLCs application programs can be best implemented and develop some prototypes. It is expected that some will be found to be most easily implemented at the PLC level while others would be best implemented at a centralized location. The capability to perform energy management functions will be evaluated and the advantages/disadvantages of PLCs over the currently used hardware in a networked system will be assessed. The results of this assessment will be used to determine the benefits of pursuing the development of a full range of energy management programs

Phase II: Develop and implement a foul range of application programs for PLCs. The application programs will be heavily oriented towards energy management functions such as demand limiting.

Potential Commercial Market: Installers of HVAC control systems would initially be the major purchaser of this product. This includes end users who install their own equipment and control contractors who do this for a living. The successful implementation of this product would open up an entirely new market for the PLC manufacturers and thus it is expected that they would purchase such a product or enter into a licensing agreement in order to sell their PLCs along with it as one integrated package. Another consumer of this product would be the so called system integrators. These firms specialize in the integration of computers, control equipment, and machinery. This product would allow them to integrate Heating, Ventilation, and Air Conditioning (HVAC) systems with PLCs which already control other types of machinery. The potential of this portion of the market is enormous due to the large number of existing PLCs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-216 TITLE: Sensors for Intelligent Low-Maintenance Corrosion Control in Industrial Water Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low-maintenance sensing package which is capable of accurate, automated measurement of key water chemistry parameters in boiler water and cooling tower systems.

DESCRIPTION: Lack of manpower resources has made it increasingly difficult for US Army installations to maintain water treatment programs for corrosion and scale control,particularly for boilers and cooling towers. Recommended periodic testing, evaluation, and analysis of problems is not done, herefore necessary adjustments to the water treatment program are not made. This results in a greatly shortened service life and reduced energy efficiency of such equipment. At some installations, boilers which are designed to last for 30 years routinely fail due to corrosion in 5 or 6 years. The heat loss due to a 1/16 inch buildup of scale on the tubes of an 80% efficient boiler which generates 50,000lbs/hr of steam results in an excess annual fuel cost of approximately $180,000. The solution is a low maintenance, automated, self-diagnostic and self-adjusting treatment system for boiler and cooling tower water. Such a system would perform water chemistry testing at the required intervals, diagnose problems, and adjust chemical feed rates accordingly or sound an alarm if it cannot correct the problem itself. The focus of this work is the development of a low-maintenance sensing package to perform testing of key water chemistry parameters and to provide electronic input for the control sys:em.

Phase I: Identify key boiler water and cooling water parameters related to corrosion control. Identify and evaluate candidate low-maintenance sensing techniques for automated measurements of these parameters.

Phase II: Fabricate a prototype low-maintenance sensing package for automated measurement of the parameters identified in Phase I.

Potential Commercial Market: This device would have many commercial applications and would be valuable for almost any user who is responsible for the operation and maintenance of boilers and cooling towers. Industrial plants, power plants, military/government installations (particularly those at remote locations), and universities are examples of potential users.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-217 TITLE: Development of Operating and Support Cost Reduction Processes in Building Construction

CATEGORY: Exploratory Development

OBJECTIVE: Develop products to enable Army facility engineers to more efficiently maintain the buildings, utilities, grounds, and supporting environmental systems. The objective is to produce products that have wide application in the building maintenance industry and that have significant impacts on reducing the cost of maintenance.

DESCRIPTION: The US Army is currently undergoing budget restraints that require drastic measures if facilities are going to be maintained in a manner to ensure a continued READY Army. The Army inventory of roads, buildings, underground piping, bridges, railroads, electrical and fluid distribution systems, heating/air conditioning systems, etc. is extensive. Budgetary constrains dictate that a better way of maintenance must be found. The Army and the natioı is looking to the research community to provide new (and use existing) technologies to help get the job done with less.

Phase I: Develop and prove the concept of an innovative approach continued (or increased) quality of service.

Phase II: Develop a marketable product that is affordable and that greatly reduces maintenance costs on one or more aspects of facility maintenance. Provide a working model to USACERL at the end of the Phase II development.

Potential Commercial Market: Facility maintenance is not unique to the US Army. State and local governments and private industry all spend large amounts of money in maintaining facilities of varied size and type. The impact of a new and extremely high market potential.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-228 TITLE: Development of Crashworthy W-Beam Guardrail Manufactured from Light-Weight Fiber Reinforced Plastics (FRP)

CATEGORY: Engineering Development

OBJECTIVE: This project is to evaluate the feasibility of using lightweight FRP for guardrails. The goal of this project is to produce FRP guardrails that have been tested for environmental durability and highway safety performance and are ready to be marketed.

DESCRIPTION: Highway and roadside safety is an ever-increasing concern for the Army, other DoD Agencies, the Federal Highway Administration, and state highway departments. Highway guardrails are presently manufactured from common materials such as aluminum, steel, and concrete. The use of a new engineering material, Fiber Reinforced Plastics (FRP), has been proposed for applications where a standard W-Beam guardrail has previously been installed. Because of improved crash worthiness, light weight, and corrosion resistance, application of FRP in the construction of guardrails is attractive for higher safety and lower costs in erection and maintenance. Since many thousands of miles of W-beam located along roadways exists

both nationally and internationally, there exists significant potential for widespread use of FRP guardrails for infrastructure rehabilitation.

Phase I: The contractor will investigate current manufacturing processes and develop new techniques to produce FRP W-beam-profile guardrails. Required physical properties include a minimum tensile strength of 70,000 psi and Young's modulus of 3,000,000 psi. Results of this work will be documented in a report. Samples of the prototype FRP W-beam guardrail totaling 100 ft. in length will be provided.

Phase II: The contractor will conduct laboratory testing and analysis to evaluate mechanical performance of the produce including effects of cold weather, ultrviolet light degradation, water resistance and flammability. The product will be subjected to full-scale vehicle crash testing at a Federal Highway Administration (FHWA) test facility, and after a successful testing, approval of the FHWA will be solicited to install the experimental guardrail on highways. As a minimum six locations in the United States will be selected covering different climatic zones, from the very hot and humid environment of the south to the severe cold climates of Alaska. The installed guardrails will be monitored for a year for indication of any degradation, or if any accidental crash has happened, the modes of failures. The results of FHWA crash test and field tests will be documented in the final report.

Potential Commercial Market: If the results prove to be commercially attractive, the research team will quickly transfer the technology and market the product. As a constructor and owner of roadway systems, the Corps of Engineers and the rest of the Army will be a user of this advanced guardrail technology. State DOT's and other local governments will also find applications in highways and local roads. This technology will have direct relevance to many infrastructure rehabilitation applications.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-232 TITLE: Development of an Asset Oriented Approach for Facility Lightning Protection

CATEGORY: Exploratory Development

OBJECTIVE: There is currently no generally accepted single methodology or approach for the evaluation of the vulnerability of systems to the effects of lightning or for the protection of systems from lightning. Such an assessment method could be used for design verification, maintenance, protection evaluation, or as a support tool for writing specifications. For example, one might hope that there would be some approved standard for such an approach, but none presently exists. The methodology currently accepted for lightning protection design occurs by default and is varied. In some cases, installing a lightning protection system (LPS) according to a standard, for example, the National Fire Protection Association (NFPA) 78, Lightning Protection Code, is adequate for insurance companies to provide insurance against lightning damage. In some cases, specialized companies using semi-quantitative methods but relying mainly on engineering judgment, survey a system and make recommendations of the LPS. Often such assessment are performed by people who are selling LPS hardware and for whom there is a conflict of interest. In some cases, an assessment might be a back-of-the-envelope type of assessment such as the one defined in the NFPA 78, Appendix I. Assests normally being protected can include the facility structure, the safety of personnel, equipment, wiring and electronic circuits, and sensitive materials such as explosives. The threats from a lightning strike can include: 1. Direct effects--where the asset is damaged by being in a direct path of all or part of the lightning current. 2. Indirect effects--where the asset is damaged by electric or magnetic fields generated by nearby lightning current. Existing manuals and specifications provide a list of things to do for lightning protection without consideration of a system's peculiar susceptibilities. The susceptibilities of assets depend on various operational configurations such as an explosive being stored in a closed container or exposed for maintenance. Closed containers usually have seams or cable penetrations which can allow the entrance or lightning energy. Those effects need to be evaluated. The objective of the effort is to develop an asset oriented evaluation and protection design methodology. This methodology will be packaged in a user friendly PC based expert system, which will be oriented towards project engineering staff.

DESCRIPTION: There are several problem areas to be addressed in this effort: 1. The usual LPS design specifications are concerned mostly with preventing side flashes: that is keeping the lightning current confined to the rods and cables comprising the LPS plus all the other metal and electrical grounding circuits which are electrically connected to the LPS. This design criteria favors the protection of building structure and the prevention of fires in combustible structural elements or the presence of flammable vapors. The criteria can compromise personnel and equipment safety in some cases and does not consider the effects of the electric and magnetic fields on internal objects connected to the LPS, nor the proximity of assets to any of the elements of the LPS. The geometrical arrangement of the LPS and the connected metals and electrical grounds will dictate the vulnerable geometrical locations of the assets, because electric and magnetic field intensities have a spatial dependence in and around the LPS. 2. The vulnerability of assets to direct or indirect effects may not be known precisely enough to judge the "safe" areas within a facility-LPS system. Conversely, the facility-LPS system may exist or be built without knowing the vulnerability of assets it may need to protect in the future. However, an existing facility may be "rated" at a particular "safety

level" and statistically "safe locations" within the facility may be declared. It may then be determined whether or not a particular asset is "safe" within that environment. 3. Any asset oriented approach needs to be easily available and understandable to a non-lightning expert.

Phase I: 1. Categorize the threat tolerance of typical assets to both direct and indirect effects. (There may be several operational configurations of a particular asset with varying degrees of exposure to threat). 2. Determine safety levels within the working volume of typical existing facilities using testing and mathematical modeling of typical facilities. 3. Determine optimum geometries for LPS design in future facilities given a set of typical assets which need protecting. 4. Obtaining generic sensitivities to electrostatic discharge (ESD) will require analysis i.e., primary explosives, pyrotechnics, propellants, high explosives, and vapors, dust and gases evolving for specific operations. 5. Develop a PC-based expert system which can perform lightning protection design and evaluation of facilities and collocated assets.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-264 TITLE: Innovative Annular Motorcase Shell Designs

CATEGORY: Exploratory Development

OBJECTIVE: Innovative filament wound annular motorcase shell designs are desirable that will eliminate current difficulties in the strain rates of the inner and outer cases, discontinuity forces at end closure and body intersections, and compressive instability of the inner shell.

DESCRIPTION: During the burn cycle of annular motorcases, the inner and outer shells are thermo-mechanically loaded as a result of the burning propellent. These loads cause the inner and outer shell to strain at different rates in the current designs. This difference in strain rates creates loads in the propellent that can threaten the integrity of the motorcase. These motor-mechanical loads can also cause discontinuity forces at the end closure and end body intersections which can lead to premature failure in this region. These thermo-mechanical loads also cause the inner shell to be in a highly compressive state of stress that typically leads to a compressive instability in the shell.

Phase I: Develop an innovative annular motorcase design that features inner and outer sheels that strain at simular rates under thermo-mechanical loading, end closure and end body intersections with minimal discontinuity forces, and a stiffened inner shell.

Phase II: Fabricate a prototype annular motorcase with the features developed in Phase I. Experimentally evaluate the performance the motorcase and the features developed in Phase I in improving the integrity of the motorcase.

Potential Commercial Market: There is a potential commercial market in numerous areas that utilize or will utilized advanced composites structures on a broad range from advanced missile weaponry to airplanes and swimming pools.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-276 TITLE: Non Eroding Nozzle Material Development

CATEGORY: Exploratory Development

OBJECTIVE: Missile control nozzles require precise and predictable performance. Current nozzle materials erode during service and in systems containing a number of control nozzles, the differences in erosion in the nozzle throats results in control compensations being required. A non-eroding nozzle material system is sought which will provide either no erosion, or small and reproducible erosion, of the nozzle throat. Multiple material systems should be considered to include carbon-carbon, metal and phenolic. Multiple material nozzles present material incompatibilities during processing which must be understood and provided for in the overall design.

DESCRIPTION: Co-processing of metal or carbon-carbon inserts are being considered for a non-eroding nozzle assembly. These multimaterial configurations induce thermal stresses, and hence the possibility of cracking between materials either during processing or firing.

Phase I: The Phase I effort will require analytical modeling of conceptual nozzles to define the magnitude of the thermal stresses developed, residual stresses after processing, and methods of reducing those residual stresses. Multiple material nozzle designs should be considered, with composite materials being designed to minimize the residual thermal stresses.

Phase II: A Phase II effort will demonstrate the design concepts by fabricating several components. Analytical tools must be demonstrated to be capable of predicting the nozzle residual stress states. Combined material and configuration optimization will be sought in the Phase II effort.

Potential Commercial Market: There is a potential commercial market in numerous areas that utilize or will utilize advanced composite structures on a broad range from advanced missile weaponry to airplanes and swimming pools.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-280 TITLE: Unstructured Grids for Computational Fluid Dynamics Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop revolutionary and innovative techniques for the application of unstructured grids in computational fluid dynamics to viscous dominated problems.

DESCRIPTION: Unstructured grids for computational fluid dynamics (CFD) applications offer a great potential for the improved design of any missile component that is governed by aerodynamic considerations. Unstructured grids have been used for many years in the area of structural analysis using finite element methods. It has only been in the past few years that this gridding technique has been applied to the coupled set of partial differential equations of fluid dynamics as opposed to the set of ordinary differential equations used in finite element structural analyses. In particular, these grids have been used very successfully for stage separation problems in multi-stage missiles. However, these solutions have been obtained only for the Euler formulation of the governing set of partial differential equations. To date, there has been no truly successful application of unstructured grids to viscous problems; yet, a successful application of these techniques to a viscous problem would revolutionize computational fluid dynamics by providing a method to solve problems with complex geometries and strong viscous dominated characteristics. To overcome this limitation, research is required in the following areas: 1. Non-orthogonal grids - The use of non-orthogonal grids have led to unstable solutions which become more unstable in direct proportion to the non-orthogonality of the grid. Algorithms are sought which do not exhibit this trend. 2. Numerical turbelence - The generation of numerical turbulence in a CFD solution is affected to a great extent by the skewness of the grid. This trend needs to be investigated to determine what factors are important in the algorithm that enhances or suppresses this numerical turbulence. 3. Turbulence model/Grid Interaction - Depending on the turbulence model used, e.g. algebraic or TKE, the CFD solution becomes more or less stable. This phenomena needs to be understood such that less sensitive solution algorithms can be developed.

Phase I: Technical approaches will be formulated for research into each of the above problem areas. At least one innovative approach will be executed through numerical experiments to assess the feasibility for improvement.

Phase II: The additional approaches formulated in Phase I will be finalized, executed, and documented leading to the incorporation of an unstructured grid capability not an existing Government computational fluid dynamics model. The advanced CFD model will be run for a series of test cases which can demonstrate the ability of the unstructured grid methodology to treat viscous dominated problems.

Potential Commercial Market: The past few years has seen an enormous growth in both the development and application of the computational fluid dynamics throughout commercial industry. The revolutionary and innovative application of unstructured grids to viscous dominated problems would open a vast new area to the application of computational fluid dynamics.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-283 TITLE: Atomization of Diesel Fuel for Combustion

CATEGORY: Exploratory Development

OBJECTIVE: Develop a laboratory prototype of a field burner operating on the principles of atomization.

DESCRIPTION: Fuel burners currently in use in field feeding equipment use vaporizing technology, requiring pressurization to achieve cold starting. For safety reasons, the burners must be fueled and preheated away from the cooking area and transported, while lit, back to the food preparation area. Advances in technology applied to atomization of fuel, such as lasers to break up fuel into fine droplets for more complete combustion and thermolectrics to more efficiently power the system, suggest the potential for designing a field burner that is clean burning, low in power consumption, with variable firing rates of from 1-3 lbs/hr. Additional goals are to produce a field burner that is rugged, lightweight, easy to maintain, and burns cleanly enough for the product of combustion to be in contact with food.

Phase I: Phase I will investigate and define the best design approach to allow atomization to occur at low firing rates now required for use with existing field equipment. Power requirements will be defines and addressed through the use of the

latest technology and trade-offs identified between function, weight, volume, safety, and reduced cost (both initial procurement and O&S). Based on the results, a model will be presented for approval by the funding agency.

Phase II: Phase II will provide a working prototype to demonstrate the practical application of the new design with existing field feeding equipment.

Potential Commercial Market: Advances in burner atomization will increase the efficiency of fuel-fired home heating units.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-288 TITLE: Development of an Immersion Water Heater for Field Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop Immersion Water Heater for multiple applications.

DESCRIPTION: Hot water for general use in the field is obtained by heating water in an open corrugated can using a liquid fuel-fired immersion heater. The heater and fuel tank are clamped to the side of the can such that the enclosed burner is immersed in the hot water. Fuel from the tank is introduced into the burner and a diffusion flame is established with the required draft provided by a tall stack. The heater is designed to operate with gasoline as the normal fuel and diesel as an emergency fuel. The overall requirements of this project shall include the development of new technology in terms of novel concepts for combustion and heat transfer that will result in a new immersion water heater design which provides clean, reliable and safe operation using a wide range of fuels, including diesel (primary), JP8 and gasoline. The new immersion water heater shall have a nominal rating of 35,000 BTU.

Phase I: The contractor shall conduct an evaluation of all requirements, an evaluation of the engineering and scientific feasibility of the project and development of an initial prototype design with supporting data and engineering sketches (level I).

Phase II: The contractor shall fabricate the prototype immersion water heater as presented in Phase I and as accepted by the Government.

Potential Commercial Market: Product of potential use in camping, outdoors recreation market. Also of potential use in disaster relief.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-291 TITLE: Closed-cycle Regenerative Field Refrigeration (CRFR)

CATEGORY: Exploratory Development

OBJECTIVE: To develop a nonpowered (nonelectric) closed-cycle solid-gas sorption refrigeration system for storage of perishable subsistence.

DESCRIPTION: Conventional field refrigeration systems require electric power, which is historically not available for field food service. The mechanical vapor compression systems are prone to failure, especially in harsh desert environments. Moreover, they use environmentally destructive CFC refrigerants. Other nonpowered refrigeration systems based on the Electrolux-Servel ammonia/water cycle are limited by size due to the use of a bubble pump. For smaller applications, ice chests require the availability of ice and are only effective for a short time. Accordingly, the CRFR should be designed with an adsorption material that can be cycled to absorb and desorb a working fluid/vapor such as ammonia or alcohol by alternating cooling and heating with either a reversible heat transfer oil loop or low grade combustion exhaust. There should be no mechanical parts other than a reversible control valve. Weight and bulk should be minimized for transportability. There are two desired regrigerator capacities. A small CRFR (8 cubic feet) with one adsorption bed for one or two day missions that could be regenerated at a central location. A large CRFR (150 cubic feet) with at least two adsorption beds for constant refrigeration.

Phase I: In Phase I the basic operative principles shall be investigated through the design and development of a proof-of-principle 8 cubic foot prototype, and the overall feasibility of the concepts shall be evaluated.

Phase II: A practical 150 cubic foot prototype shall be developed in the second phase to be used for preliminary field demonstration (6.3A).

Potential Commercial Market: Disaster relief, emergencies, remote areas, third world countries, recreation, recreation vehicles (vans and yachts).

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-292 TITLE: Diesel-Fired and JP8-Fired Lantern for Field Use

CATEGORY: Exploratory Development

OBJECTIVE: Development of a compact, portable, cleanburning, efficient field lantern fueled by diesel and JP8.

DESCRIPTION: With the current plan for a single fuel Army, there is a need to replace the current gasoline-fired lantern with one capable of burning diesel or JP8 fuels. Current lantern designs do not efficiently burn diesel fuel, particularly at low temperatures. The overall requirement of this project shall include the development of a compact, easily portable lantern capable of operating cleanly and efficiently on diesel or JP8 fuel. The lantern shall be capable of operation in temperature extremes ranging from -40 to 120 F. The lantern shall be durable enough for field use and transport and shall require no external power source. The lantern shall provide a minimum output of 250 Candle Power.

Phase I: Phase I shall include evaluation of all requirements, evaluation of the engineering and scientific feasibility of the project, and development of an initial prototype with supporting data to prove the concept.

Phase II: Phase II shall include the development of a portable diesel/JP8-fired prototype lantern suitable for field evaluation.

Potential Commercial Market: Product is of potential use for the camping and outdoors recreation industry.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-298 TITLE: Modular Microclimate Conditioning System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a man-portable, lightweight, compact and modular cooling, heating and air purification system for the Individual Soldier.

DESCRIPTION: A modular cooling, heating and air purification system must be provided to protect the combat soldier in all environments, including NBC environment. The microclimate conditioning system must weigh 10 or less pounds and must provide the encapsulated soldier with the ability to conduct missions of up to 12 hours in duration regardless of ambient temperatures and humidity with the actual duration being dependent on the work rate.

Phase I: Investigate the feasibility of potential conditioning technologies and identify those that show high potential in meeting the stated objective.

Phase II: Develop a working prototype of one or more of the technologies identified in Phase I and demonstrate the effectiveness of the system against performance criteria.

Potential Commercial Market: Use in the entertainment industry by those in full body costumes, use in humanitarian relief efforts i.e. Somalia.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-351 TITLE: Concurrent Engineering (CE) Tool for Diagnostics

CATEGORY: Exploratory Development

OBJECTIVE: The Concurrent Engineering (CE) tool for diagnostics will help automate the testability/support aspects of a system design and implementation.

DESCRIPTION: The tool will use automated preliminary design criteria (i.e., BHDL, CAD models, etc.), for early models and be refined as the system design matures. The CE tool will supply a cost benefits analysis of the system, and supply necessary documentation for design reviews.

Phase I: This phase will evaluate the technology and propose a development of necessary software. A demonstration of feasibility is highly desirable.

Phase II: This phase will deliver a working prototype to prove the proposed benefits.

Potential Commercial Market: The purpose of this SBIR is to encourage the incorporation of "testability" in the system design process so design for testability has the same weight as other system design criteria.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-352 TITLE: Prognostic Methodologies for Electronics or Mechanical Systems

CATEGORY: Exploratory Development

OBJECTIVE: Investigate new technologies which can be used in the evaluation of a system or equipment for potential or impending malfunctions.

DESCRIPTION: Currently we have no field usable tool that can predict whether a weapon system can accomplish a required mission. We have mathematical algorithms to perform prediction/forecasting analyses, however, these require manpower intensive actions to input data necessary for predictions and forecast. In addition there is little information available on the kinds of information that would provide the best input elements for prognostics. This task is to develop a usable real time prognostics tool to supply usable information to the field mechanic on potential or impending malfunctions on his system and to investigate the types of input data that should be used in such a tool.

Phase I: This phase will consist of a feasibility study and proposal. A demonstration of feasibility is highly desirable.

Phase II: This phase will deliver a working prototype to prove the proposed benefits.

Potential Commercial Market: These prognostic technologies will be able to predict the health of a system and would be applicable to such areas as system safety, supply and mission planning.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-364 TITLE: Equipment and Procedures for Placement of Dowel Bars in Hardened Concrete

CATEGORY: Exploratory Development

OBJECTIVE: Develop equipment and procedures for the insertion and proper alignment of dowel bars for load transfer in hardened concrete.

DESCRIPTION: The procedures and equipment developed should provide for the placement of dowel bars in the proper alignment. It is assumed that the holes shall be pre drilled to a diameter just slightly greater than that of the dowel to be inserted and with proper orientation and spacing. It is desirable that the majority of equipment selected or modified be commercially available from several manufacturers. Detailed construction procedures and equipment are required covering hole preparation and insertion to assure requirements for placement and orientation are satisfied.

Phase I: Possible procedures and equipment should be evaluated for proper placement of the dowel bars. The most promising procedures and equipment should be selected for initial testing and evaluation. Information should be obtained concerning ease of installation, costs, and effectiveness. Final procedures and equipment should be detailed in a specification format.

Phase II: Demonstrate the procedures and equipment in the field for proper placement of dowel bars. Verify proper orientation and that all void areas around the dowel have been filled with the bonding epoxy cement.

Potential Commercial Market: Concrete pavement rehabilitation (load transfer between slabs is crucial for long term pavement performance).

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-365 TITLE: Ground Penetrating Radar for Pavement Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop an instrumentation system, based on ground-penetrating short-pulse radar (GPR), that is capable of producing a continuous readout of pavement layer thicknesses and depth to bedrock.

DESCRIPTION: The GPR system should be micro-computer controlled and should contain all electronics, interface equipment, and software necessary for data acquisition and interpretation. The system should be adaptable to standard vehicles or nondestructive test (NDT) equipment such as the falling weight deflectometer. The system should be capable of operating in a continuous mode with color graphical and digital output. The system must be rugged and well suited for field use. Instruments exposed to the elements shall be operable in the temperature range of minus 10 to plus 50 degrees Celsius and shall tolerate relatively high humidity, rain or spray, and all other adverse conditions such as dust, shock, and vibrations that may normally be encountered. Instruments not exposed to the elements shall be operable in the temperature range of 5 to 40 degrees

Celsius. The system should contain multiple antennae capable of continuously resolving surface, base, and subbase layer thicknesses within 3 feet of the pavement surface while simultaneously searching for bedrock to a depth of 20 feet.

Phase I: Design a prototype test configuration with associated software that is self calibrating and capable of providing a continuous readout of pavement layer thicknesses and depth to bedrock. Include laboratory and field tests to validate antennae design and frequency requirements. Submit results to Army sponsor for design review. Include data flow diagram, software development plan, equipment layout and interconnect diagram, system specifications, and test results.

Phase II: Finalize the approved design and fabricate a GPR system in accordance project requirements for continuous pavement layer thickness measurement and simultaneous detection of depth to bedrock. Test and validate the performance of the system under controlled lab conditions and with a range of actual pavements. Furnish the results and working system to the Army sponsor for evaluation.

Potential Commercial Market: This system will be directly applicable to all types of pavements, including airfields, roads, streets, parking lots and building floors with a wide range of DOD, DOT, State, and commercial applications.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-366 TITLE: Laser Range Sensor for Pavement Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a laser sensor and associated test interface equipment necessary for continuous measurement of pavement profile and deflection under loading.

DESCRIPTION: The laser device should be micro-computer controlled and should contain all electronics, interface equipment, and software necessary for data acquisition. The system should be adaptable to a variety of test vehicles and capable of operating in both continuous and static modes. The system should be capable of accurately measuring the deflected profile for a moving wheel load. A deflection basin defined continuously from the load axis radially outward to a minimum distance of 72 inches is required. The system must be rugged and well suited for field use. Instruments exposed to the elements shall be operable in the temperature range of minus 10 to 50 degrees Celsius and shall tolerate relatively high humidity, rain or spray, and all other adverse conditions such as dust, shock, and vibrations that may normally be encountered. Instruments not exposed to the elements shall be operable in the temperature range of 5 to 40 degrees Celsius. The system should be capable of continuously measuring vertical movement of a pavement with an accuracy of +/- 2 percent or +/- .08 mils, whichever is greater; and if recorded, the minimum resolution shall not be more that .04 mils.

Phase I: Design a prototype sensor to evaluate the feasibility of meeting project requirements using laser technology. This should include laboratory tests on pavement samples to validate optical system model calculations concerning all critical parameters of a laser range sensor including precision, bandwidth, and laser power. At this point a design review will be held. The system design will be furnished to the Army sponsor. Include sensor design, top-level functional block diagram, data flow diagram, software development plan, equipment layout and interconnect diagram.

Phase II: Finalize the approved design and fabricate a laser sensor system in accordance with project requirements for continuous surface profile and pavement deflection measurements. Test and validate the performance of the system under controlled static lab conditions and dynamically with actual pavements. Furnish the results and working system to the Army sponsor for evaluation.

Potential Commercial Market: This technology represents a new generation of pavement measurement equipment and can be used to advance and improve analytical and performance prediction capabilities. This system will be directly applicable to all types of pavements and railroads with a wide range of DOD, DOT, State, and commercial applications.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research. The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
800 North Quincy Street, BCT #1, Room 922
Arlington, VA 22217-5660
(703) 696-4286

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's mission is to maintain the freedom of the open seas. To that end the Navy employs and maintains air, land and ocean going vehicles and personnel necessary to accomplish this mission. The topics on the following pages represent a portion of the problems encountered by the Navy in order to fulfill its mission.

The Navy has identified 165 technical topics in this, the second of two SBIR solicitations to be released during FY 1993 by DOD to which small R&D businesses may respond. The reason for the increase in the amount of topics is due to a change in the law PL 102-564 which was signed by the President on 28 October 1992. Under PL 102-564, the "cap" for Phase I and Phase II was increased and the need for a process to fund the gap between Phases I and II was noted. Consequently, the Phase I proposals resulting from this Navy portion of the solicitation will be funded at a $70K level (unless otherwise noted) for the initial Phase I portion with an option phase also submitted with the Phase I proposal. The option should not exceed $30K and should propose an effort that would form the initial part of Phase II. Therefore, the total proposal submitted for this solicitation for the initial Phase I and the Phase I option will be $100K.

Those who have finished or almost finished their "initial Phase I" portion and who have been invited to submit their Phase II proposal should do so with an "initial Phase II" portion and an option. The Phase II proposal should contain a plan of how the proposer will commercialize the technology to the government (and the private sector) in addition to the technology demonstration portion of the proposal. At the end of the "initial Phase II" portion, a determination will be made by the Navy as to whether the proposer has satisfied the commercialization plan sufficiently for the government to fund the "Phase II option" portion of the proposal. The total Phase II funding will not exceed $750K with 80% going to the "initial Phase II" portion and 20% for the "option Phase II" portion.

Selection of Phase I proposals for funding is based upon technical merit and the evaluation criteria contained in this solicitation document. Because funding is limited, the Navy reserves the right to limit the amount of awards funded under any topic and only those proposals considered to be of superior quality will be funded.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Topic Nos. N93-133 through N93-140

Administrative SBIR Contact

Mail/Handcarry Address:

Office of Naval Research
Attn: ONR Code 11SP, Room 804
SBIR Program, Topic No. N93-_____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5660

Dr. Donald Polk
(703) 696-4103

Topic Nos. N93-141 through N93-150

Mail Address:

Commander
Marine Corps Systems Command
Attn: Code AW, SBIR Program, Topic No. N93-_____
Quantico, VA 22134-5080

Mr. Joseph Johnson
(703) 640-4801/2761

Handcarry Address:

Commander
Marine Corps Systems Command
Attn: Code AW, SBIR Program, Topic No. N93-_____
Building #3097, 2nd Deck, Room 13
Quantico, VA 22134-5080

Topic Nos. N93-151 through N93-177

Mail Address:

Commander
Space and Naval Warfare Systems Command
Attn: Code SPAWAR OOK, SBIR Program, Topic No. N93-_____
Washington, DC 20363-5100

Ms. Betty Geesey
(703) 602-6092

Handcarry Address:

Commander
Space and Naval Warfare Systems Command
Attn: Code SPAWAR OOK, SBIR Program, Topic No. N93-_____
Crystal Park #5, Room 110
2451 Crystal Drive
Arlington, VA 22202

Topic Nos. N93-178 through N93-180	Administrative SBIR Contact

Mail Address:

Commander
Naval Supply Systems Command
Attn: Code SUP 4233D, SBIR Program, Topic No. N93-_____
Washington, DC 20376-5000

Ms. Linda Whittington
(703) 607-1648

Handcarry Address:

Commander
Naval Supply Systems Command
Attn: Code SUP 4233D, SBIR Program, Topic No. N93-_____
Crystal Mall #3, Room 710
1931 Jefferson Davis Highway
Arlington, VA 22202

Topic Nos. N93-181 and N93-182

Mail/Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Attn: Code L03B, SBIR Program, Topic No. N93-_____
Port Hueneme, CA 93043-5003

Mr. Daniel Zarate
(805) 982-1057

Topic Nos. N93-183 through N93-188

Mail Address:

Commanding Officer
Navy Personnel Research and Development Center
Attn: Code 13, SBIR Program, Topic No. N93-_____
San Diego, CA 92152-7250

Dr. Meryl S. Baker
(619) 553-7681

Handcarry Address:

Commanding Officer
Navy Personnel Research and Development Center
Attn: Code 13, SBIR Program, Topic No. N93-_____
53335 Ryne Road
San Diego, CA 92152-7250

Topic Nos. N93-189 through N93-244

Mail Address:

Commander
Naval Air Systems Command
Attn: Code AIR-05TE2, SBIR Program, Topic No. N93-_____
Washington, DC 20361

Mr. Tom Drago
(703) 692-7393

Handcarry Address:

Administrative
SBIR Contact

Commander
Naval Air Systems Command
Attn: Code AIR-05TE2, SBIR Program, Topic No. N93-_____
1411 Jefferson Davis Highway
Jefferson Plaza #1, Room 444
Arlington, VA 22202

Topic Nos. N93-245 through N93-271

Mail Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B, SBIR Program, Topic No. N93-_____
P.O. Box 5152
Warminster, PA 18974-0591

Ms. Carol Van Wyk
(215) 441-2375

Handcarry Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B, SBIR Program, Topic No. N93-_____
Street Road/Jacksonville Road
Warminster, PA 18974-0591

Topic Nos. N93-272 through N93-278

Mail Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Trenton
Attn: Code PE31, SBIR Program, Topic No. N93-_____
Trenton, NJ 08628-0176

Mr. Robert Dobrowolski
(609) 538-6754

Handcarry Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Trenton
6250 Phillips Boulevard
Trenton, NJ 08628-0176

Topic No. N93-279	<u>Administrative</u> <u>SBIR Contact</u>

<u>Mailing Address</u>:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Indianapolis
Attn: Code DP7010N/MS-31, SBIR Program, Topic No. N93-_____
Indianapolis, IN 46219-2189

Mr. Larry Halbig
(317) 353-3838

<u>Handcarry Address</u>:

Commanding Officer
Naval Air Warfare Center
Attn: Code DP7010N/MS-31, SBIR Program, Topic No. N93-_____
6000 East 21st Street
Indianapolis, IN 46219-2189

Topic No. N93-280

<u>Mail Address</u>:

Commander
Naval Surface Warfare Center
Dahlgren Division
Attn: Code R05, SBIR Program, Topic No. N93-_____
Silver Spring, MD 20903-5000

Mr. Donald Wilson
(301) 394 -1279

<u>Handcarry Address</u>:

Commander
Naval Surface Warfare Center
White Oak Detachment
Attn: Code R05, SBIR Program, Topic No. N93-_____
Building #1, Reception Room
Silver Spring, MD 20903-5000

Topic Nos. N93-281 through N93-287

<u>Mailing Address</u>:

Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT222, SBIR Program, Topic No. N93-_____
Patuxent River, MD 20670-5304

Mr. Daniel Watters
(301) 826-1144

<u>Handcarry Address</u>:

Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT222, SBIR Program, Topic No. N93-_____
Building #304
Patuxent River, MD 20670-5304

Topic Nos. N93-288 through N93-291	**Administrative SBIR Contact**

Topic Nos. N93-288 through N93-291

Mailing Address:

Commanding Officer
Naval Research Laboratory
Attn: Code 3204, SBIR Program, Topic No. N93-_____
Washington, DC 20375-5326

Ms. Patricia Schaefer
(202) 767-6263

Handcarry Address:

Commanding Officer
Naval Research Laboratory
Attn: Code 3204, SBIR Program, Topic No. N93-_____
4555 Overlook Avenue, SW
Building, 222, Room 115
Washington, DC 20375-5326

Topic Nos. N93-292 through N93-295

Mailing Address:

Commander
Naval Air Warfare Center
Weapons Division
Attn: Code C002, SBIR Program, Topic No. N93-_____
China Lake, CA 93555-6001

Ms. Lois Herrington
(619) 939-2712

Handcarry Address:

Commander
Naval Air Warfare Center
Weapons Division
Attn: Code C002, SBIR Program, Topic No. N93-_____
515 Blandy Avenue, Annex A1
China Lake, CA 93555-6001

Topic No. N93-296

Mail Address:

Commanding Officer
Naval Command, Control and Ocean
Surveillance Center (RDT&E) Division
Attn: Code 0144, SBIR Program, Topic No. N93-_____
San Diego, CA 92152-5043

Dr. Richard November
(619) 553-2103

Handcarry Address:

Commanding Officer
Naval Command, Control and Ocean
Surveillance Center (RDT&E) Division
Attn: Code 0144, SBIR Program, Topic No. N93-_____
271 Catalina Boulevard
San Diego, CA 92152-5043

Topic No. N93-297

Administrative
SBIR Contact

Mailing Address:

Commander
Naval Air Warfare Center
Weapons Division Point Mugu
Attn: Code P3410, SBIR Program, Topic N93-_____
Point Mugu, CA 93042-5000

Handcarry Address:

Commander
Naval Air Warefare Center
Attn: Code P3410, SBIR Program, Topic N93-_____
Building 50, Room 1092
Point Mugu, CA 93042-5000

Mr. Eugene Patno
(805) 989-8801

SUBJECT/WORD INDEX TO THE NAVY SBIR SOLICITATION

SUBJECT/WORD **TOPIC NO.**

DEPARTMENT OF THE NAVY
SBIR TOPIC INDEX
DOD SOLICITATION 93.2

N93-156	Periodically Time Varying Interference Filters
N93-157	Instantaneous Frequency Measurement Unit (IFMU)
N93-158	Remote Identification of Unique Artificial Materials
N93-159	Beamforming a Free Floating Sonobuoy Field with Interference Rejection **(CANCELLED)**
N93-160	Active Surveillance System Signal Processing for Dense Multipath Near Land Warfare Environments
N93-161	Fishing Vessel Contact Formation
N93-162	Images from Low Frequency Active Sonar
N93-163	Joint Surveillance Data Fusion
N93-164	Workstation Architecture as a Function of Open Systems Architecture Warfare Systems
N93-165	Survey of Intrusion Detection Systems
N93-166	Development of Dynamic Management Tool for High Performance Local Area Networks
N93-167	Distributed Real Time Computer Networks
N93-168	Multimedia Technology Insertion into Open Systems Architectures
N93-169	SHF/EHF Submarine Communications Mast Antenna
N93-170	Covert Submarine Battle Group Communications
N93-171	High Dynamic Range Wide Band Receiver Front End
N93-172	Artificial Intelligence (AI) for Command and Control
N93-173	Battle Group Tactical Decision Aid and Training Tool
N93-174	Molecular Density Storage Disk
N93-175	SHF Array Antenna
N93-176	C^3 Computer Assisted Communications
N93-177	Passive Remote Sensing of Meteorological Parameters

<u>NAVAL SUPPLY SYSTEMS COMMAND</u>

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<u>NAVAL CIVIL ENGINEERING LABORATORY</u>

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NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER (NPRDC)

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N93-184	Identification of Knowledge Structures Underlying a Task Process Model
N93-185	Software Development for Linking Cognitive Styles with Instructional Strategies
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NAVAL AIR SYSTEMS COMMAND

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N93-191	High-Speed Opto-Electronic Processing
N93-192	Avionics Architecture/Data Bus Configuration
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N93-195	Expeditionary Lighting
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N93-200	Risk Reduction Management System
N93-201	JTIDS/MIDS Displays Optimization
N93-202	ADA Software Reliability Measurement Tools **(CANCELLED)**
N93-203	Software Code Translation From Assembly to Ada **(CANCELLED)**
N93-204	Bar Code Implementation for F/A-18 Production and USN Field Accounting
N93-205	Joint Tactical Information Distribution Systems/Multifunctional Information Distribution System (JTIDS/MIDS) Cooperative Tactics
N93-206	Communication Network Saturation

N93-207	Sensor Data Interface Definitions for Tactical Reconnaissance Systems
N93-208	Reconnaissance Data Recording
N93-209	Identification of Alternative Compliant Refrigerants to Replace Ozone Depleting Substances (ODS) Chemicals for Air Conditioning/Refrigeration Purposes in F/A-18 Aircraft.
N93-210	Development of Improved Battery for the Miniaturized Airborne GPS Receiver (MAGR)
N93-211	Development of Surface Mount Repair Tools/Operator Training
N93-212	Electronically Erasable Programmable Read Only Memory (EEPROM) Failure Mode Analysis
N93-213	Product Data Exchange Standard (PDES) Parser **(CANCELLED)**
N93-214	Data Storage Unit (DSU) Data Analysis **(CANCELLED)**
N93-215	AutoTEST Model Vhsic Hardware Descriptive Language (VHDL) Parser **(CANCELLED)**
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N93-217	Development of Tools for CALS Implementation
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N93-221	NDE/I Assessment of Heat Damage to Advanced Composites
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N93-224	Conformal UHF SATCOM Antenna for Tactical Aircraft
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N93-226	Integrating Computer Aided Curing of Composites with Advanced Tooling Concepts **(CANCELLED)**
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N93-229	Centrifugal Filtration of Corrosive Process Solutions
N93-230	Sodium Bicarbonate Blast Decreasing and Recycling
N93-231	Real-Time Wavelet-Based Image Compression
N93-232	Government Wide/Para-Military Applications of Unmanned Air Vehicles (UAVs)
N93-233	Unmanned Aerial Vehicle Electronic Decoy Payload
N93-234	Automatic Target Recognition/Cuing Using an Unmanned Aerial Vehicle Multispectral Imaging Sensor

N93-235	EO/IR Sensor Integration for Target Identification
N93-236	EO/IR Sensor Integration/Fusion for Target Identification
N93-237	Solid State Digital Data Buffer
N93-238	Digital Data Compression/Decompression Algorithms
N93-239	Computer Algorithms
N93-240	Sidewinder 9X Missile Domes **(CANCELLED)**
N93-241	Simulation Enhancement of the FA-18 Flight Simulation with Special Emphasis on Departures and Out-of-Control Airplane Motions and Control Power **(CANCELLED)**
N93-242	NDE/I Assessment of Adhesive Bond Strength **(CANCELLED)**
N93-243	Aircraft Repair and Modification Cost Estimating Query System
N93-244	Novel Magnetic Detection Schemes based on Cooperative Phenomena in Nonlinear Dynamic Systems

NAVAL AIR WARFARE CENTER/WARMINSTER

N93-245	Forward Looking Infrared (FLIR) Image Enhancement
N93-246	Antenna/Airframe Math Model
N93-247	Low-Cost Tow Preg.
N93-248	Low-cost Prototype (Composite) Tooling
N93-249	Fabrication of Thermoplastic Secondary Structures for V-22
N93-250	Woven Structure/Resin Transfer Molding
N93-251	Onboard Electrical Load Management of V-22 Aircraft Power Systems
N93-252	Innovative ECM System for Tilt Rotor/Rotary Wing Aircraft
N93-253	Metal Matrix Composite Components
N93-254	Self-adaptive Notch Filter for the V-22 Flight Controls
N93-255	Simplified "Health of the Aircraft" Sensing System
N93-256	CBR Agent Detector for the V-22
N93-257	Agent Decontamination for the V-22
N93-258	Laser Radar for Terrain Following/Terrain Avoidance (TF/TA)
N93-259	Composite Cockpit Cage
N93-260	High Temperature Advanced Composite Drive Shafts
N93-261	Covert Forward Looking Sensor for V-22

N93-262	Explosive Sound Source Design Aid **(CANCELLED)**
N93-263	Variable Coherent Sound Source
N93-264	High-Temperature Self-Lubrication Ceramic Bearings
N93-265	Fiber-Optically Coupled Laser Beam Forming and Steering Device for Multipurpose Airborne Laser Application
N93-266	High Speed Low-power Optical Receiver with Clock Recovery for Digital Communications
N93-267	High Density Power Amplifier for Low Frequency Active Sonobuoys
N93-268	Loading System for Nondestructive Testing
N93-269	Machinability of AF 1410 and AerMet 100 High Strength Steels
N93-270	Compact Tunable Optical Filter for Fiber Optic Communications
N93-271	Genetic Algorithms for Flight Control Optimization

NAVAL AIR WARFARE CENTER/TRENTON

N93-272	Powder-Metallurgy Net-Shape Process
N93-273	Lightweight, Active Noise Suppression for Small Diesel Engines
N93-274	Innovative Lightweight Hybrid Diesel/Electric Propulsion System for Unmanned Air Vehicles (UAV)
N93-275	High Speed and Temperature Counter-Rotating Intershaft Seals for Aviation Turbine Engines
N93-276	Next Generation Electrochemical Machining (ECM) Electrolytes
N93-277	Innovative and Durable Flexible Shafts For Power Transmission In Unmanned Air Vehicle Propulsion Systems
N93-278	Performance Optimizing Full Authority Digital Electronic Control (FADEC) for High Speed Spark Assisted Diesel Engines

NAVAL AIR WARFARE CENTER/INDIANAPOLIS

N93-279	Embedded GPS Requirements (EGR) Compliant GPS

NAVAL SURFACE WARFARE CENTER/DAHLGREN - WHITE OAK

N93-280	Significance of Ultrasonic Detected Defects in Composites

NAVAL AIR WARFARE CENTER/PATUXENT RIVER

N93-281	Ice Impact Protection for Thin Skin Composite Laminates
N93-282	Sensors for Icing Avoidance, Detection and Accretion Measurement
N93-283	Flight Test Instrumentation to Measure Rotor System Motion and Loads in Navy Helicopters
N93-284	Real Time Simulation Aerodynamic Updates for Flight Test Support

N93-285 Ship Based Helicopter Position/Motion Resolving Instrumentation System

N93-286 Flight Test Instrumentation to Measure Rotor System Motion and Loads in Navy Helicopters

N93-287 Variable Twist Rotor Blade to Optimize Tilt Rotor Aircraft Performance

NAVAL RESEARCH LABORATORY

N93-288 Rapid Prototyping and Simulation with Programmable Gate Arrays

N93-289 Airborne Sensor Front End Signal Processing Unit

N93-290 Airborne Multispectral Sensor Arrays

N93-291 Passive Tracking for Countermeasure Effectiveness

NAVAL AIR WARFARE CENTER/CHINA LAKE

N93-292 Pulsed Detonation Engine

N93-293 M197, 20mm Sabot Deflector Retrofit Kit **(CANCELLED)**

N93-294 Electrochemical Milling/Finishing of Rifling in Gun Barrels

N93-295 Develop an Improved Thrust Vector Control Jet Vane

NCCOSC/NRAD/SAN DIEGO

N93-296 Microcircuit Device Package Marking and Recognition

NAVAL AIR WARFARE CENTER/POINT MUGU

N93-297 Integrated IR/RF Scene Generation for Closed-Loop Missile Engagement Simulators

DEPARTMENT OF THE NAVY
SBIR TOPIC DESCRIPTIONS
DOD SOLICITATION 93.2

OFFICE OF NAVAL RESEARCH

N93-133 TITLE: (Scanning Tunneling Microscope) STM-Based Instrument for Nanolithography

CATEGORY: Research; Semiconductor Materials and Microelectronic Circuits

OBJECTIVE: To develop an STM-type instrument with a wide scan field (20 μm by 20 μm minimum) where the tip can be moved laterally at a speed of at least 20 um/s and be positioned with an accuracy of 10 nm or better. The instrument should be able to accommodate a full 3-inch wafer.

DESCRIPTION: Proximal probe techniques based on the scanning tunneling microscope (STM) are important for lithography because the low energy, spatially confined electron beam can be used to fabricate and characterize structures in the nanometer size regime. Present instruments have limitations in accuracy and throughput due to the nonlinear and limited time response of the piezo actuators used for moving the STM tip. The voltages applied to the actuators do not give a sufficiently accurate measure of the position of the STM tip. Both optical (interferometric or deflection) and electronic (capacitive) approaches may be considered for monitoring tip position. Parallel fast and slow servo systems may be required to achieve the desired scan speed and accuracy. A coarse sample positioned and optical microscope access for tip/sample alignment are required. The instrument should be capable of operating in a controlled ambient and in ultrahigh vacuum (< 10^{-10} torr). (funding for this Phase I topic will not exceed $60,000)

PHASE I: Demonstrate the feasibility of an instrument with the above specifications by developing an overall system design and validating this design through fabrication and characterization of critical subsystems.

PHASE II: Develop and optimize the full instrument which must include a state-of-the-art translation stage for accurate (< 5 nm) lateral movement of the sample to reposition the tip to a different 20 μm by 20 μm scan field.

PHASE III: Develop an instrument suitable for DoD and commercial lithography applications. This version should be expandable to accommodate an array of independently movable (in x, y & z) tips for increased throughput. The above listed specifications for speed and accuracy will be required for each tip.

N93-134 TITLE: Super High Density Memory Device

CATEGORY: Research; Electronics

OBJECTIVE: To develop super high density digital memory device capable of storing, reading, and writing 25 terabits per square centimeter with bit-access time in the tens of nanoseconds.

DESCRIPTION: The inexhaustible demand for higher density has pushed the digital memory device technology to megabits using solid state devices. An innovative approach to super high density digital memory is to use Scanning Tunneling Microscope (STM) as the driver for writing and reading bits of stored information at the atomic level. A cluster of a few atoms, deposited in a small area called a unit cell, can serve as the basic structure for storing one bit of information. The presence and absence of the small cluster of metal atoms within the cell can be read by the STM probe to indicate the bit of information. Since the unit cell can be as small as 2 nm, the memory density can approach 25 trillion bits per square centimeter. This is five orders of magnitude more dense than the densest solid state memory chip today (256 MB). The writing process consists of deposition of a cluster of metal atoms in a cell of the thin film lattice, and the reading process is the scanning of the cells in sequence in order to detect the presence of the metal atom clusters. Bit access time approaching the tens of nanoseconds appears to be possible using the STM. Other approaches will also be considered if they can achieve the same or better packing density and access time. (funding for this Phase I topic will not exceed $60,000)

PHASE I: Demonstrate the feasibility of using thin film substrate as a medium for the storage of digital bit information and using the STM as a driver to read and write the unit cells at the required dimensions and speed. The strength of the signals from the STM to drive the sense amplifier and the reliability of bit-detection will be demonstrated.

PHASE II: Full scale development of the super high density digital memory device to achieve the 25 terabit per square centimeter density and tens of nanoseconds bit-access time. The product is expected to be a fully developed super high density digital memory system that is compatible with conventional memory systems for digital computers and/or video

storage systems.

PHASE III: The product developed under Phase II is to be made available and aggressively marketed to the computer and video storage industry. This phase is not expected to be funded by the Government.

N93-135 TITLE: 4-Dimensional Oceanographic Instrumentation

CATEGORY: Research: Weapon System Environment

OBJECTIVE: To develop innovative instrumentation to measure oceanographic/meteorologic parameters

DESCRIPTION: Innovative sensors/projectors and measurement techniques are solicited to obtain marine atmospheric and/or oceanographic (acoustical, optical, physical, biological, chemical, and geophysical) variables in 3D space and time. The emphasis is on (1) novel approaches and concepts for measuring multiple parameters coherently in 4D; (2) new methods of measuring fluxes, acoustic wavefields, or fluid motion of mixtures (i.e. water/bubbles/sediments/ biologics). Instruments can be towed/tethered sensors/projectors, elements in arrays, or suites of instruments on ROVs (remotely operated vehicles) to cite a few examples. Low cost, reliable, and/or expendable sensors/projectors and components (e.g. broadband, large dynamic range, high efficiency, compact, low power consumption projector/receivers) are particularly desirable. Full depth capability is desired in instrumentation planned for subsurface use. (funding for this topic will not exceed $60,000)

The PHASE I proposal should provide a description of exactly what will be measured and to what accuracies and coherence as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II would develop hardware and demonstrate feasibility in the laboratory. Field testing should be addressed via coordination with ongoing ONR field efforts. Potential approaches to industrial development that transition program output should also be outlined.

PHASE III would initiate production of hardware for both commercial and military monitoring of oceanographic and/or marine atmospheric parameters.

N93-136 TITLE: Low Power Mass Storage Devices

CATEGORY: Research; Semiconductor Materials and Microelectronic Circuits; Signal Processing

DESCRIPTION: Mass storage devices (MSD) are now available commercially that range from 0.5 to 4 Gbyte storage capacity, permitting unprecedented amounts of data collection. These devices, typically 10 watts of power, have been adapted or developed for computer peripherals, assuming a constant source of power. Many oceanographic instruments powered by batteries, however, sample at low rates (typically less than 100 samples/second), and buffer the data in memory before transfer to the mass medium for final storage. To minimize power consumption, the MSD's are powered down when not in use. When power is applied prior to transfer, almost every device has to recycle through all the prior data to find the next point on the medium for writing. This consumes most of the power utilized in operating the MSD, not in actually transferring the data. What is urgently needed is an MSD capable of operating in harsh environments (-10°C to +100°C, +/- 45° tilt, vibration, etc.) that can be powered on/off with minimal time spent relocating the write pointer. Oceanographic/environmental usage potentially could exceed 10,000 units, with commercial adaptation to portable computers powered by battery for subsurface use. (funding for this Phase I topic will not exceed $60,000)

PHASE I: Design or adapt currently available MSD controllers, software, and/or hardware to determine the feasibility of immediate write capability for devices capable of over 500 Mbyte capacity under harsh environmental conditions. If funds allow, construct/modify a prototype device.

PHASE II: Apply the knowledge gained in Phase I to build several devices that can be placed in existing oceanographic instrumentation and tested under real-world conditions.

PHASE III: Depending upon the results in Phase II, finalize the design, and mass produce (100's) the MSD device for other DoD/Navy instruments. Commercialize and fabricate the MSD for portable computer peripherals.

N93-137 TITLE: Acoustic Transducer Material Fabrication

CATEGORY: Research; Passive Sensors; Signature Control

OBJECTIVE: Devise cost-effective methods to synthesize innovative transducer materials for sensors and actuators.

DESCRIPTION: Previous research efforts have identified routes to enhance electro-mechanical transducer materials, for example, with piezoelectric ceramic/polymer composites. Such advanced materials promise significant improvements in the performance of many Naval and civilian systems, for example, pulse-echo acoustic imaging transducers used in undersea mine detection and medical diagnostics, and structural composites incorporating sensors and actuators for active control of vibrations in ships, aircraft, and automobiles. Cost-effective methods to synthesize these materials are essential to exploit such advanced materials concepts in Naval and commercial applications.(funding for this Phase I topic will not exceed $60,000)

PHASE I: Demonstrate potentially cost-effective methods to synthesize innovative transducer materials with enhanced properties. Identify targeted application(s) where these improved properties will have significant impact.

PHASE II: Optimize materials synthesis methods to demonstrate: (1) production of such materials in sufficient quantity and with sufficient reproducibility to permit their evaluation in prototype devices and (2) that eventual production costs will be sufficiently low.

PHASE III: Produce the advanced transducer materials in pilot line quantities and supply them to Naval and industrial laboratories for incorporation in practical device structures.

N93-138 TITLE: Software Tools for Formal Specification and Verification of Distributed Real-Time Systems

CATEGORY: Research; Software Producibility

OBJECTIVE: To develop and demonstrate interactive software tools that support formal specification and reasoning about the temporal behavior, correctness, and safety of hard real-time systems.

DESCRIPTION: A number of advances have been made over the last several years in basic research on formal methods for specification and verification of hard real-time systems. Diverse approaches, ranging from temporal logics to timed automata to process algebras, have been developed, each with its own advantages and limitations with respect to expressibility, scope, proof complexity, scalability, etc. Ultimately, evaluation and comparison of these approaches will require implementation and validation on real (or representative) applications. Of particular interest to the Navy are tools that (1) support the formal specification and modeling of concurrency and timing constraints; (2) provide useful analyses of the formal specification to the user; and (3) exhibit scalability.(funding for this Phase I topic will not exceed $60,000)

PHASE I: Devise prototype components and demonstrate the feasibility of the proposed formal approach on generalizations of narrowly focussed research problems and representative subset(s) of real applications. Provide evidence of scalability (either theoretical or experimental). Develop a functional design for the complete toolset and a design for a robust, friendly user interface for the toolset. Develop a software design based on software engineering principles of the toolset. Formulate criteria for the quantitative and qualitative evaluation of the system, including experiments to be performed, measurements to be taken, and how they are to be interpreted.

PHASE II: Build a prototype of the complete toolset designed in Phase I. Demonstrate its power, scalability, and ease of use on a representative benchmark suite and evaluate the overall system using the plan established in Phase I. Refine the functional design, the software design, and the interface design based on the experimentation conducted in Phase I to the point where useful software tools can be built.

PHASE III: Construct a robust, maintainable, version of the toolset and make available to Navy sites involved in the design of C^3 systems. Commercialize the software for use in real-time process control, transportation, and communications applications.

N93-139 TITLE: Legged Vehicle for Underwater Mobile Operations

CATEGORY: Research; Robotics

OBJECTIVE: To develop a prototype small legged vehicle capable of stable locomotion underwater for the purpose of

performing tasks in near-shore oceanic environments.

DESCRIPTION: Recent developments in small legged robots for terrestrial locomotion have demonstrated the feasibility of stable locomotion with minimal visual input. There is a need for underwater exploration of ocean bottoms for oceanography, bottom tomography, harbor pollution assessment, and ship husbandry, where some degree of autonomous control is desirable, and where currents or surges produce substantial perturbations. Biomechanical and neural analysis of invertebrate locomotion and recent concepts in coupled nonlinear oscillators are providing substantial opportunities for developing new adaptive control strategies for stable locomotion with on-board computational resources. This effort will develop a prototype capable of underwater legged locomotion in the presence of fluid perturbations.(funding for this Phase I topic will not exceed $60,000)

PHASE I: Demonstrate feasibility of a proposed design based on biological principles for a small legged vehicle capable of immersion and stable locomotion in the presence of perturbations that would be encountered in a shallow water environment. Formalize model for ambulation controller and specify performance requirements for actuators in a single leg implementation.

PHASE II: Develop and construct a prototype small legged vehicle, and demonstrate dynamically stable locomotion, maneuvering and navigation in a shallow tank with a sandy bottom and rock obstacles. Demonstrate stability in presence of waves or surges. At this stage of development the vehicle can be tethered with computer resources off-board.

PHASE III: Develop and construct a fully-autonomous legged vehicle capable of adapting to water currents and surge while navigating.

N93-140 TITLE: Active/Passive Hybrid Approach for Noise and Vibration Control

CATEGORY: Research; Signature Control

OBJECTIVE: Develop and demonstrate active/passive hybrid approach for noise and vibration control

DESCRIPTION: Active control of noise and vibration has received a great deal of attention and has achieved a certain level of practicality. However, active control methods have some drawbacks that are undesirable for many applications, including the potential for instability, need for significant power, and control complexity. An alternative, an active/passive hybrid approach (also known as adaptive passive), is attractive from simplicity and cost point of view. Active/passive hybrid methods utilize the reactive or damping characteristics of traditional passive techniques but have the capability to adapt parameters to optimize performance over a range of operating conditions. In contrast to active control, active/passive hybrid strategies add no energy to the system. Consequently, this alternative has no potential for instability and requires minimal power.(funding for this Phase I topic will not exceed $60,000)

PHASE I: Feasibility study: examine active/passive hybrid control concept and compare with active control and conventional passive techniques. Factors to be compared include acoustic performance, controller design, complexity of control system, and power consumption. Based on results of comparisons, select candidate(s) for further development and demonstration.

PHASE II: Develop active/passive hybrid control methodology and demonstrate concept. These efforts will be conducted in the laboratory with scaled models for the candidate(s) selected in Phase I.

PHASE III: Transition active/passive hybrid control methodology to practical and engineering problems.

MARINE CORPS SYSTEMS COMMAND

N93-141 TITLE: Gun System Calibration

This topic is CANCELLED.

N93-142 TITLE: Gun System Alignment Fixture

This topic is CANCELLED.

N93-143 TITLE: Universal Driver's Display

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Explore new and innovative approaches to display vehicle parameters to the driver and monitor vehicle and engine parameters that could result in failure.

DESCRIPTION: The current Drivers Display Unit displays 8 bar graphs that monitors various functions. The proposed replacement monitor should be a color capable screen (similar to a lap top screen) that would continuously display driver information such as: vehicle speed, engine speed, and vehicle compass heading.
In addition, the other parameters should be monitored continuously and displayed by exception. These parameters should be, but not be limited to: engine temperature, engine oil pressure, generator output, transmission oil pressure, and hydraulic system pressure. The display device should also have the capability of storing the exception information that may be accessed later by a laptop computer for maintenance diagnosis.

PHASE I: At the end of six (6) months, the contractor(s) should provide a number of approaches that are possible solutions to the problem. The proposals should be of sufficient detail to allow for government to consider follow-on research.

PHASE II: At end of the two year effort, it is anticipated that one or two technical approaches will have been installed and tested in an AAVC7A1 vehicle.

PHASE III: If successful, it is expected that such an approach will have immediate benefit for AAV, other combat vehicles and likely private sector.

N93-144 TITLE: Auxiliary Power Unit

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Explore new and innovative approaches for auxiliary electrical generation equipment.

DESCRIPTION: The current Auxiliary Power Units using usual materials, designs and implementations generally result in large bulky designs with limited performance inadequate for combat vehicle application.
Any proposed replacements should be of smaller size and lower weight than those commonly available. Specific desirable attributes and performance are as follows: 10-15 KW Total, 7.5 KW DC, 3-8, KW AC Weighs less than 175 pounds, diesel Powered, Low audible and smoke signature, Fits in a minimal space, i.e.,
17 x 17 x 42, Generally a one horsepower per cubic inch displacement for a 25 horsepower engine is considered good.

PHASE I: At end of six (6) months, the contractor(s) should provide a number of approaches that are possible solutions to the problem. The proposals should be of sufficient detail to allow for government to consider follow-on research.

PHASE II: At end of the two year effort, it is anticipated that one or two technical approaches will have been installed and tested in an AAVC7A1 vehicle.

PHASE III: If successful it is expected that such an approach will have immediate benefit for AAV, other combat vehicles and likely private sector.

N93-145 TITLE: Powder Metallurgy Processes for Net-Shape Complex Parts Using Dissimilar Materials

CATEGORY: Advanced Development; Composite Materials

OBJECTIVES: The goal of this topic is to develop powder metallurgical processes by which to form net-shape parts to be used in a variety of applications including projectiles and shaped-charge liners.

DESCRIPTION: Dissimilar metals, metalloid, alloys, or ceramics should be formed into structural composites without developing significant interfacial phases. The beginning powders, which will be provided by the government agency, will vary in density; the particle size will be less than 50 u.m. The powders should be evenly mixed, and structural parts should be fabricated from them. The parts are not restricted to a given geometry and may vary in size and shape.

PHASE I: The contractor will be responsible for delivering a report that will provide a summary of the

background survey conducted on the topic, a detailed description of the approach that will be undertaken to solve the problem, and detailed projected production and scale-up costs (to project the costs, use the shapes described in Phase II). It is understood that some of the projected costs will vary depending on the complexity of the shapes produced. The contractor will also be responsible for providing two parts that demonstrate that the technology is feasible.

PHASE II: At the end of Phase II, the contractor will be responsible for delivering the following items: 1) Twenty five parts of each of the following geometries: a simple cone with a radius apex, and a hemispherical shell. The dimensions of the parts should be as follows: 1 inch in diameter, 1/2 inch in height, and a 0.050 inch in wall thickness. The allowable tolerances are as follows: wall thickness variation on transverse plane 0.0027 inch, goal variation 0.00004 inch; maximum variation in wall thickness throughout part 0.0030 inch, goal variation 0.0006; concentricity with casing 0.0023 inch, goal 0.0012. 2) A final report containing a detailed description of the process used to attain the parts, with information on different parameters, and specifically on percent theoretical density, whether this can be varied (a minimum and a maximum), and how it effects mechanical properties.

PHASE III: Provided successful completion of the ALE/MPTS effort, it is conceivable that this technology be incorporated in the production of the newly developed projectiles. Other programs currently in 6.2 and 6.3 categories could benefit from the use of this technology.

N93-146 TITLE: Shape Memory Material for Lashing and Rigging

CATEGORY: Exploratory Development; Composite Materials

OBJECTIVE: Identify and evaluate shape memory material systems for adaptation to sling and tie-down/restraint requirements.

DESCRIPTION: Current lashing and rigging systems are resource and time intensive. Reduction in resources and an increase in tempo associated with Navy littoral warfare and Marine Corps maneuver warfare operations requires faster equipment and materials securing and stowing methods aboard ships, lighters, ground vehicles and/or slinging method from air craft and helicopters. The lashing and rigging material system shall be capable of being relaxed or contracted by electrical, physical and/or chemical stimuli.

PHASE I: A detailed report shall be produced which describes the concept(s) and provides sufficient scientific and engineering analysis to substantiate its feasibility. Technologies identified must show the potential to be more efficient than current industry practice. A test plan shall also be developed for physical demonstrating candidate laboratory system(s) concept in Phase II.

PHASE II: Develop, test and evaluate candidate system(s) identified under Phase I. Candidate system(s) shall demonstrate the capability of proposed system(s) to have a potential capacity of 40 psi shear strength and a 10,000 lb.. tie down strength.

PHASE III: Phase III effort is anticipated to take advantage of the results of this effort through the commercial sector and potential procurement with Marine Corps and other DoD applications.

N93-147 TITLE: Thermal Protection for Munitions Packaging

CATEGORY: Exploratory Development: Weapon System Environment

OBJECTIVE: Explore and evaluate off-the-shelf thermal protection systems to identify materials that will protect munitions in their shipping containers from fire and high heat exposure.

DESCRIPTION: Protecting munition containers to prevent explosive material from reaching the temperature at which they will undergo a violent thermally induced burning, deflagration, or detonation reaction.

PHASE I: Review NSWC (Naval Surface Warfare Center/Dahlgren Div) test results to determine feasibility of NDI technological application to existing munition containers.

PHASE II: Establishment of Department of Transportation (DOT) packaging standards for the use of thermal protection systems on munition containers. Selection of preferred thermal protection system. Application of thermal protection technology to existing munition containers. Evaluate alternative thermal resistant materials to be used in the construction of munition containers.

PHASE III: Incorporate thermal protection technology in the fabrication and manufacturing of munition shipping

containers and existing specifications.

N93-148 TITLE: Toxic Free/Lead Free Small Arms Ammunition

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: This topic has two objectives. First, explore and evaluate off-the-shelf toxic free/lead free small arms ammunition to resolve lead toxicity problems on firing ranges. Second, it is expected this research will aid in the development of a frangible or controlled penetration cartridge, currently required for Military Operations in Urban Terrain Training, through the development of new projectile compositions to eliminate use of lead.

DESCRIPTION: To eliminate toxicity, especially lead toxicity, of existing military cartridges to enhance user and environmental safety while maintaining weapon functionality and reliability. Additionally, to enhance live fire training opportunities by minimizing damage to training facilities through the use of frangible projectiles.

PHASE I: Evaluate NSWC preliminary results to determine possible NDI candidates for type classification.

PHASE II: Select NDI candidate, procure sufficient quantities for extensive type classification tests. Establish Joint Operation Requirements Document.

PHASE III: Proceed with full scale procurement actions.

N93-149 TITLE: Saboted Light Armor Penetrator Ammunition

CATEGORY: Engineering Development; Weapon System Environment; Flexible Manufacturing.

OBJECTIVE: Evaluate commercial engineering developments to improve the existing .50 caliber Saboted Light Armor Penetrator (SLAP).

DESCRIPTION: Improve the performance characteristics, composition, and manufacturing technique of the existing .50 caliber SLAP round while reducing unit cost.

PHASE I: Review NDI engineering developments to evaluate documented performance characteristics and cost proposals of a .50 caliber Improved-SLAP.

PHASE II: Procure different types of commercially available .50 caliber I-SLAP rounds to conduct performance tests. Select NDI candidate, procure sufficient quantities for extensive type classification tests.

PHASE III: Proceed with procurement.

N93-150 TITLE: Image Object Recognition Processor

CATEGORY: Advanced Development/Signal Processing

OBJECTIVE: Develop Compact Digital Real-Time Neural Network Image Object Recognition Processor.

DESCRIPTION: Neural networks have demonstrated the ability to extract objects and features from complex scene images generated from Video, IR, acoustic, and Rf sensors. The specific paradigms and the network weights are dependent on the architecture and training set. The ability to map the neural architecture and training set. The ability to map the neural architecture unto a chip or chips will provide a rapidly fieldable system. Neural architectures are composed of simple operations dependent on the paradigm and architecture. An architecture is necessary that will support the primitives of neural paradigms in Phase I. In Phase II the architecture will be integrated unto a chip or chip set. The real-time ability to extract objects will then be demonstrated.

PHASE I: Develop an architecture compatible with an IR imaging sensor supporting neural paradigms for object extraction and recognition.

PHASE II: Demonstrate the integration of the neural architecture into a chip or chip set. The real-time capability to extract and classify objects will then be demonstrated.

PHASE III: Develop and demonstrate the real-time capability of the neural architecture hardware to extract and classify objects. Target systems could include the Advanced Sensor for Air Defense Program, Expendable Artillery Remote

Sensor (EARS) Program, or the Forward Observer Program.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N93-151 TITLE: Quantum Overt Technique Exchange Systems (QUOTE)

CATEGORY: Research, Photonics

OBJECTIVE: Provide a means, based on quantum cryptography, of exchanging information for the purpose of discreet decision making.

DESCRIPTION: Quantum cryptography exploits the unavoidable disturbance of photons of light when an eavesdropper intrudes on a polarized communications channel employing light generators with quantum correlation. In cases where multi-level security is desired, where joint decisions are made based on separately private information, or where authentication is the issue, quantum cryptography may have important applications. Although devices have been built, they have mathematical inefficiencies. Schemes using an information-processing procedure called oblivious transfer have recently been described which could well be the most promising application of quantum devices.

PHASE I: Study the mathematical approach and feasibility of constructing a quantum device for use in short distance (local) links, such as a ship automatic switching system or a shore-based, multi-national control complex.

PHASE II: Demonstrate a proof of concept model at a land based operational setting.

PHASE III: A successful Phase II will have worldwide significance for DoD and a profound effect on commercial applications for privacy protection of individuals and businesses.

N93-152 TITLE: New Space Electronic Warfare (SEW) Synthetic Environment

CATEGORY: Exploratory Development; Machine Intelligence/Robotics

OBJECTIVE: The objective is to develop and demonstrate a methodology for generating a SEW synthetic environment and which will be suitable for worldwide internet connectivity.

DESCRIPTION: SEW system functional capabilities are offensive and defensive; and utilizes critical resources from three areas: Space and Surveillance, C4I and Electronic Combat. SEW is a new joint Warfare Area which integrates Surveillance, Electronic Combat, and Command, Control Computers and Intelligence (C4I). Few, if any, SEW system elements will be constructed and technical feasibility demonstrated using breadboard, brassboard or advanced development models, prior to a program decision milestone, where a value determination or military utility decision is usually made. Program decision will be made, in the future, on performance estimates of simulated warfare supersystems of the highest complexity...that is, synthetic environments embodying many systems, of a great variety of sizes, shapes and performances, with many variables, netted together with other large scale synthetic environments. Once operating this complex supersystem defines the war fighting operational system of the future. To assure that SEW is made an integral part of the overall war fighting operational system of the future, it is important to develop and demonstrate a methodology for generating a SEW synthetic environment, which is compatible with the larger synthetic environment.

PHASE I: The basic thrust of the Phase I development is to investigate the requisite characteristics of the SEW synthetic environment, primarily for Navy elements. Synthetic environments are internetted simulations which represent activities with a high level of realism. These environments are fundamentally different from the traditional simulations and models known today. The basic Phase I goal is to produce an initial feasibility analysis, and develop an implementation or demonstration plan for Phase II.

PHASE II: Phase II should accomplish critical SEA synthetic environment developments and demonstrations. Potential Phase II developments include a preliminary synthetic design using a SEW environment configured with multiple netted PCs and interface design/adaption to agreed upon connectivity requirements. The implementation of the SEW synthetic environment should demonstrate realistic properties, limits and potentially useful features. This SEW synthetic environment should serve as entry to the larger synthetic war fighting environment.

PHASE III: This phase will transition preliminary synthetic designs into networked simulations of integrated Space and Electronic Warfare Systems.

N93-153 TITLE: Command and Control Information Management

CATEGORY: Engineering Development; Data Fusion

OBJECTIVE: Develop an automated decision support tool using Commercial Off-The-Shelf (COTS) software to devolve qualitative warfare information requirements to quantitative data elements for dynamic sensor collection and determine the value of quantitative sensor data to satisfy qualitative information needs.

DESCRIPTION: The Navy requires timely and accurate all-source early warning information at all command levels to maximize the use of available assets. To satisfy a Commander's Essential Elements of Information (EEIs) requires a means to translate qualitative information needs to quantitative data elements for technical sensor collection. It also requires a means to assess the value of reported data and the adequacy of specific EEIs. Phase I shall be a concept definition phase and survey of available COTS tools to support the development of an automated information-to-data and data-to-information process. Phase II shall provide a proof of concept demonstration of the process for operational testing. Each phase shall require an initial brief that details the Plan Of Action and Milestones (POA&M) for the phase, a final review, and a final report.

PHASE I: Phase I will provide a process model for demonstration in Phase II, an evaluation of COTS tools to implement the process, and a POA&M for Phase II.

PHASE II: Phase II will demonstrate a proof of concept system in a specified operational setting.

PHASE III: Phase III will transition a successful proof of concept to approved Navy systems for incorporation in the Unified Build.

N93-154 TITLE: Aegis Cueing from Acoustic Detection of Missile and Aircraft Overflight

This topic is CANCELLED.

N93-155 TITLE: Decision Support Tool to Support Naval Force Planning

CATEGORY: Research; Simulation and Modeling

OBJECTIVE: Develop and demonstrate a decision support tool to support long range naval force and acquisition planning.

DESCRIPTION: An automated decision support tool that will allow U.S. Navy warfare systems architects and acquisition planners to assess and prioritize alternative force structures and alternative future systems acquisitions is needed. The system must be capable of comparing forces and systems across warfare mission areas and should allow the appraisal of naval forces to be based on contribution to joint war fighting capability. The system should be flexible enough to address a broad range of uncertainty. Navy and DoD decision makers must know that their choices will maximize warfare capability over a wide range of assumptions made in the size, composition and quality of projected threats, and in the conditions under which the future wars might be fought. The system is envisioned as a tool that will allow appraisals of alternative naval force structures and systems to be based on their ability to influence the outcome of a series of approved regional planning scenarios. However, the tool to be developed must resolve certain deficiencies that exist with current campaign level force-on-force models. The ability of naval forces to influence the outcome of a land campaign depends on the value to the campaign outcome of the operational tasks assigned to naval power projection forces and systems. The process is complicated by the requirement to protect high value launch platforms. To insure that the value of forces and weapons are accurately estimated, the tool must provide a systematic way to assign available resources to competing operational tasks and targets so as to maximize the benefit of the weapons tc the campaign. to insure the opponent cannot negate the value of a force improvement by changing his strategy, the mechanisms must work for both sides. The system must also address the problem of timeliness. To support the decision process, the system, in its ultimate configuration, should be capable of supporting prompt analyses of a number of force structure alternatives. The required turnaround time may be as short as a few hours or days.

PHASE I: Design the configuration of the Phase II deliverable and develop a working prototype system. The prototype will be capable of estimating the value of example weapons systems across multiple warfare mission areas in multiple regional scenarios.

PHASE II: At the end of Phase II, the contractor will deliver a fully operational system with source code,

operators manual and analyst guide.

PHASE III: A Navy funded Phase III effort is anticipated if a useful decision support tool is provided in Phase II.

N93-156 TITLE: Periodically Time Varying Interference Filters

CATEGORY: Exploratory Development; Signal Processing

OBJECTIVE: Develop techniques for eliminating co-channel interference when both Signals of Interest (SOIs) and Signals Not Of Interest (SNOIs) are broadband and spectrally overlapping.

DESCRIPTION: Interference rejection filters in use today are based on the theory of time invariant linear systems which are optimal for use in a wide-sense stationary signal environment. These approaches include notch filters as well as adaptive transversal filters. Unfortunately, real signal environments almost always contain interfering signals which are not wide-sense stationary. In many cases however, the interfering signals are wide-sense cyclostationary or periodically correlated. It can be shown that a periodically time variant filter is optimal in these situations. Using a PTV filter, signals that are spectrally overlapping can be separated completely without degradation to the SOI.

PHASE I: Conduct a 6 month study to determine the value of periodically time varying FIR filters for separating spectrally overlapped signals. The study will involve simulation of the technique and processing combinations of several signal types.

PHASE II: Develop and implement the periodically time varying interference filter in a signal processing work station environment. Apply the technique to several real data sets. Data will consist of dense communications scenarios including cellular radio with frequency reuse.

PHASE III: The technique will be transitioned to a Government owned signal analysis work station. Another possible application is improved cellular communications.

N93-157 TITLE: Instantaneous Frequency Measurement Unit (IFMU)

CATEGORY: Advanced Development; Semiconductor Materials, Microelectronic Circuits

OBJECTIVE: Develop the capability to obtain more accurate and faster frequency measurement capabilities.

DESCRIPTION: Measure the frequency of an RF pulsed signal in the frequency range of 2-6 GHz (goal) within 100 nano-seconds (goals) of signal receipt. Resolution requirements are on the order of several megahertz or less. Size of the unit is to be as small as possible.

PHASE I: Phase I efforts will be to develop a preliminary design for further implementation. The Phase I proposals should address how the key features of the design will be capable of meeting the stringent timing and accuracy requirements. Design tradeoffs required to validate approach.

PHASE II: Phase II efforts will be to take the design of Phase I to the critical design phase. Final design trades and a proposal to take the IFMU to a hardware implementation is required.

PHASE III: Anticipated use of the IFMU is classified.

N93-158 TITLE: Remote Identification of Unique Artificial Materials

CATEGORY: Exploratory Development; Passive Signals

OBJECTIVE: Develop methods for producing low cost sensors or modifying existing sensors to remotely identify artificial materials that have unique spectral signatures.

DESCRIPTION: Design and fabricate low cost sensor systems capable of remotely identifying artificial materials having unique spectral signatures. Identification may be achieved through the detection of either reflected or emitted energy. The preparation of test materials, the fabrication of a prototype low-cost sensor, and proposed approaches for modifying operational sensors are required.

PHASE I: Will include the identification of candidate test materials along with a description of how these materials will be fabricated. The design of a low-cost sensor prototype will be generated. This design will include expected operational performance predictions with supporting analyses, top level schematics and drawings, a projected schedule for fabrication, and a cost projection for the production of operational sensors with supporting data. A detailed description of actions required to modify an existing sensor such as FLIR will be developed. The impact of the proposed modification will be identified.

PHASE II: Prepare unique test materials and obtain high resolution spectral signatures. Support collection exercises with panels ((4X8) feet) coated with the unique materials. Fabricate a low-cost sensor prototype and support testing in a simulated operational environment. Extend the modification analysis to additional sensor systems.

PHASE III: The use of remote identification of unique artificial materials in Navy operations is anticipated.

N93-159 TITLE: Beamforming a Free Floating Sonobuoy Field with Interference Rejection

This topic is CANCELLED.

N93-160 TITLE: Active Surveillance System Signal Processing for Dense Multipath Near Land Warfare Environments

CATEGORY: Exploratory Development; Signal Processing

OBJECTIVE: Develop, demonstrate, test and evaluate innovative LFA monostatic and bistatic active signal processing techniques that will improve detection and classification performance in the dense multipath environments associated with near land warfare.

DESCRIPTION: The increasing emphasis on active echo ranging in shallow water near land warfare environments requires that signal and signal sequence designs and processing algorithms perform well in dense multipath environments. The multipath structure is unknown or difficult to predict in shallow water and is changing in time due to non-uniform bottom topology within the source-target-receiver changing geometries and raypaths. Echo returns from the different multipaths are smeared in time a. d, when the paths are resolvable, produce similar smearing of the conventional matched filter output peaks. The task is to develop, demonstrate and measure innovative algorithms/techniques required to automatically combine multipaths for detection improvement and differentiate propagation multipath from target multipath to improve classification performance. Coherent combining using the latest adaptive filtering techniques as well as the more traditional incoherent post matched filtering techniques should be considered. LFA signal and signal sequence design options and multipath sorting in time and frequency are candidate study topics for detection and classification enhancements. A specific algorithm processing chain is desired along with the estimated processing gain improvements.

PHASE I: Develop algorithms and implement a software simulation of the critical candidate processing functions suitable for testing with simulated and recorded sea data. Provide preliminary test results along with a detailed algorithm description. Prepare Phase II Test Plan.

PHASE II: Develop a complete software processing chain suitable for near real time testing of large quantities of recorded sea data with commercial hardware and prepare a detailed algorithm and software specification.

PHASE III: Develop software and hardware for extensive on site testing and prepare on site test plans.

N93-161 TITLE: Fishing Vessel Contact Formation

CATEGORY: Advanced Development; Signal Processing, Passive Sensors

OBJECTIVE: To demonstrate the benefits of applying IUSS detection and classification capabilities to the protection of marine resources.

DESCRIPTION: The Navy's undersea surveillance mission requires highly capable personnel. To maintain the technical edge needed, and to continue to enhance capabilities in target identification and tracking, a need exists to perform in-depth analysis of acoustic data of interest which heretofore has been referred to as "background noise". This noise includes, prominently, emissions from commercial fishing vessels which produce identifiable acoustic signatures which can be

monitored with current IUSS capabilities. Currently, there is a need in the fisheries community for the capability to perform wide-area search and to locate and classify fishing vessels in order to assist in the prevention of illegal exploitation of fisheries. Most prominently, efforts must be undertaken to limit worldwide whaling activities. In support of current and planned treaties, surveillance is needed to maintain a watch on whaling vessels and their prey; namely, the whales themselves. Fortunately, many of the whale species of interest are likewise strong acoustic sources, capable of being located, classified and tracked.

PHASE I: Provide a detailed feasibility study of the application of existing IUSS sensor systems for contact formation of commercial fishing vessels and whales. The feasibility study will include the use of both fixed (SOSUS) and mobile (SURTASS) acoustic arrays, including the potential benefit of dedicated flights of maritime patrol aircraft. Included should be a discussion of the optimal mix of sensors to be used, along with an estimate of results to be anticipated and an analysis of costs and benefits.

PHASE II: Design an experiment to collect signals of interest and to correlate them with known sources. With Navy cooperation, collect these data and analyze them. Demonstrate monitoring of fishing vessels engaged in various activities, and whales, individually or in groups.

PHASE III: Convert the techniques refined in Phases I and II to an on-line system usable by Navy ocean technicians, fisheries personnel and marine biologists.

N93-162 TITLE: Images from Low Frequency Active Sonar

CATEGORY: Exploratory Development; Signal Processing

OBJECTIVE: Develop a system to form images from Low Frequency Active returns for surveillance of diesel-electric and closed cycle submarines.

DESCRIPTION: Low Frequency Active multistatic systems can detect the very quiet targets of the future. As yet these systems have no classification capability. The problem is to provide such a capability by forming images of the target using multistatic Low Frequency Active returns. These returns could be observed at a number of nearby arrays and beamformed using self calibration techniques. The set of observing arrays would constitute a single wide aperture array with sufficient resolution to form an image of the target. The image would be used for classification. In particular, an untrained person can quickly distinguish textural qualities. Machine-assisted textural analysis could provide analysis of noise in sonar data, detection and classification of quiet sources, and advancement of machine vision.

PHASE I: Provide an analysis of the chosen imaging system. Include a discussion of receiving array type and location, self calibration technique, sensitivity, resolution and concept of operations. Include a conceptual visualization demo.

PHASE II: Design an at-sea experiment to collect data suitable for off-line processing to demonstrate proof-of-concept. With Navy cooperation, collect these data and analyze them. Using the lessons learned from this experiment, design a system for sea trials in Phase III.

PHASE III: The Phase III prototype system will be constructed with non-Navy funds.

N93-163 TITLE: Joint Surveillance Data Fusion

CATEGORY: Exploratory Development; Data Fusion, Signal Processing

OBJECTIVE: To develop algorithms to perform data fusion in a Joint Surveillance architecture.

DESCRIPTION: A Joint Surveillance requirement exists to provide systematic observation, tracking and dissemination of all activity (surface, subsurface, and air) within or affecting a theater of operations by all available sensors. Accomplishments of this will require integration of surveillance information from all sensor sources including Theater, Organic, and Non-traditional. Fusion of the data will provide users the ability to pull the required information to afloat or ashore activities, and will provide the mechanism to access the information aggregate. Surveillance information will be provided "bundled" in a usable format by contact, mission (ASW, ASUW, etc.) with tracks based on multiple sensors.

PHASE I: Conduct detailed analysis to determine the scope and bounds of the surveillance sensor fusion requirements needed to support a Joint Surveillance Program and examine potential algorithms and algorithm development to accomplish the data fusion and the timely dissemination to tactical users.

PHASE II: Design a system to demonstrate a Joint Surveillance Program using existing software and algorithms or new algorithms, as appropriate. Plan to test the Joint Surveillance Program in a realistic environment and support such an experiment. Provide an analysis of test results and recommendations in a final report. The Navy will cooperate and support the contractor's design, test and analysis efforts.

PHASE III: A transition to Phase III is planned.

N93-164 TITLE: Workstation Architecture as a Function of Open Systems Architecture Warfare Systems

CATEGORY: Exploratory Development; Parallel Computer Architectures, Weapon System Environment

OBJECTIVE: To determine how technology innovations related to the emergence of the Open Systems Architecture (OSA) philosophy can best be implemented in workstations that will be a part of future warfare systems.

DESCRIPTION: The two most far reaching recent developments in warfare systems design have been the use of the OSA philosophy in the design of computer systems and the advances in workstation technology. With these innovations, the complexion of warfare systems is rapidly changing. It is important that we understand the implications of these changes on warfare systems. This should be performed through analysis of the functional areas of a warfare system and, following the OSA concept, design of modules for the overall system that map to these functions.

PHASE I: Phase I will analyze the design and functionality issues in implementing OSAs in future workstations. At the end of six months a technical report covering implementation issues will be delivered. As part of this report, recommendations for the design features required in future warfare system OSA workstations will be developed.

PHASE II: Phase II will consist of implementing critical design features, as described in the Phase I report, in a workstation environment.

PHASE III: Results of this research are expected to be incorporated into TAC-5 and other workstation efforts.

N93-165 TITLE: Survey of Intrusion Detection Systems

CATEGORY: Exploratory Development; Machine Intelligence

OBJECTIVE: Evaluate intrusion detection systems to determine standard features required to safeguard Navy computing systems.

DESCRIPTION: One method of protecting computers and networks from unauthorized use is through the use of access controls, such as passwords; however, if these access controls can be compromised or bypassed, an abuser may gain unauthorized access and cause great damage and disruption to system operation. Although a computer system's first line of defense is its access controls, such mechanisms cannot be relied upon in every case to safeguard against penetration or insider attack. Even the most secure systems are vulnerable to abuse by insiders who misuse their privileges, and audit trails may then be the only means of detecting this type of abusive user activity. Intrusion detection systems detect unusual and anomalous computer system/user behavior and draw intelligent conclusions about the seriousness of that behavior, with the primary purpose of detecting misuse. Widespread use of intrusion detection systems required that standards be developed to facilitate commercialization. Exploratory development is needed which benefits from an evaluation of current intrusion detection systems and facilitates the recommendation of standard features required to safeguard Navy computer systems.

PHASE I: Identify and evaluate intrusion detection systems, both currently available and in development, and determine the ability of each to detect misuse in Navy computer systems. Develop recommendations for standard features for intrusion detection systems required to safeguard Navy computer systems. Priority should be placed on those features which facilitate commercialization.

PHASE II: Design/specify a prototype intrusion detection system which embodies the standard features recommended as part of the Phase I effort. Develop documentation and briefing materials to aid SPAWAR in preparing for a Phase III prototype development program.

PHASE III: Based on the results of Phase II, an intrusion detection system prototype development program may be pursued. Commercialization of this technology or a spin-off into the private sector is envisioned.

N93-166 TITLE: Development of Dynamic Management Tool for High Performance Local Area Networks

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Develop and prototype a software network management tool which allows a high performance network to make dynamic decisions as to which adaptable parameters and algorithms should be readjusted when the network experiences dramatic and abrupt change in command and control operations.

DESCRIPTION: Navy command and control systems require the effective use of message priority assignments and network resource utilization. It is critical that a high performance tactical (i.e. real-time) network for mission critical computer systems be able to dynamically adjust its network and system parameters and services, such as those associated with the MAC, Transport layer, flow control windows, and higher layer messaging. This adaptation must permit acceptable throughput and minimized delays to critical messages and streams, while best supporting other demanding messaging and imaging flows.

PHASE I: Phase I efforts will develop a detailed plan and analysis for incorporating the software developed in Phase II into a high speed local area network. The Phase I proposal should address how dynamic adjustments to the network are to be accomplished to maintain highly reliable network performance and how the reconfiguration of network parameters is to be initiated. The key tactical feature desired is the minimization of critical messages delays.

PHASE II: Develop engineer development models with the resulting software integrated into a fiber optic network, primarily the SAFENET profiles.

PHASE III: Anticipated future use in high speed Navy shipboard networks.

N93-167 TITLE: Distributed Real Time Computer Networks

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Identify requirements of a local area network (LAN) and a system of interconnected LAN's to support real time DOD applications, real time operating systems, and real time databases.

DESCRIPTION: As computer technology advances into the real time domain and as information technology advances into the distributed domain, there needs to be a computer communications paradigm to support future real time distributed systems. Computer communication protocols (FTP/TCP/IP, OSI 7 layers) began in the 1970's with the goal of interoperability between heterogeneous computer systems. Technology advances increased performance of computers and networks and interoperability is no longer the only functionality required of network protocols. Currently, ANSI and ISO are working on High Speed protocols to address the increased performance of hardware over the past 15 years. However, these address only efficiency issues and not realtime issues such as scheduling, predictability, synchronization, and latency control. Recently, research and development for predictability and scheduling of operating system processes have produced realtime operating systems for single platforms. As systems become more geographically distributed, these realtime mechanisms within the operating systems will require extensions into the communications area to transfer data and information in a predictable fashion to meet (sometimes critical) deadlines.

PHASE I: Survey of present technology and standards activity as well as Navy shipboard and ashore computer communications needs. This will identify the critical realtime parameters (e.g. latency, traffic priorities and scheduling, synchronization, bandwidth) and those technologies and standards that are addressing at least in part, the communications performance to meet these needs. Put together a plan to integrate these technologies into a distributed system that will meet these critical parameters. This includes integrating priorities and scheduling into the operating systems, protocol processing, LAN access, and inter-LAN connectivity (routing).

PHASE II: Model and simulate this system, using various Navy shipboard and ashore scenarios to demonstrate several realtime aspects of the system (e.g. traffic overload situation, scheduling distributed tasks, synchronizing events over different processors). This simulation should have a graphical interface to make the results easily understandable and demonstrable.

PHASE III: This distributed system will have various subsystems (e.g. network routers, network access protocols, operating system schedulers). Phase III could implement any number of these subsystems to verify the models.

N93-168 TITLE: Multimedia Technology Insertion into Open Systems Architectures

CATEGORY: Exploratory Development; Simulation and Modeling, Weapon System Environment, Data Fusion

OBJECTIVE: To determine how multimedia can best be implemented in emerging Navy Command and Control systems that will be implemented using an Open Systems Architecture (OSA) philosophy.

DESCRIPTION: Multimedia Technology (MMT) includes a broad spectrum of new and emerging capabilities for future Navy systems. These systems shall incorporate raw video, computer generated imagery, video image storage and retrieval, audio, interactive video, video conferencing, and their integration into true multimedia environments.
In order for Navy Command and Control systems to exploit this technology, innovative approaches are needed to: 1) incorporate MMT into OSA, 2) acquire, store, and retrieve large quantities and new types of MMT data, and 3) determine standardized interfaces for MMT capabilities. Use of commercial-off-the-shelf MMT is encouraged.

PHASE I: Phase I will consist of the description and implementation of the engineering approach, resulting in a feasibility demonstration.

PHASE II: Phase II will consist of the selection of open system compatible interfaces and products, ending with demonstrations of their integration and utility in the C^2 arena.

PHASE III: Results of this research are expected to be incorporated into TAC-5 and other workstation efforts.

N93-169 TITLE: SHF/EHF Submarine Communications Mast Antenna

CATEGORY: Research; Submarine Antennas

OBJECTIVE: Develop a concept for a submarine RF mast antenna system which provides SHF and EHF transceiver communications. The system shall support present and future tactical communications requirements.

DESCRIPTION: Develop submarine RF mast antenna system concepts using one sail mounted retractable mast which allows the submarine to communicate at SHF and EHF while at periscope speeds and depths. The system shall be capable of simultaneous and individual link communications. Variable data rate, and transceiver capability to support future copernicus requirements.

PHASE I: Address concept designs, RF operational performance, and trade-off studies.

PHASE II: Design and build prototype for test and evaluation to demonstrate feasibility of the concepts.

PHASE III: Anticipate Navy sponsorship to transition into Submarine Communications Antenna Improvement Initiative.

N93-170 TITLE: Covert Submarine Battle Group Communications

CATEGORY: Research; Covert Submarine Communications, LPI

OBJECTIVE: Develop a covert, timely technique for communicating between the battle group and subsurface craft.

DESCRIPTION: Navy battle groups demand real time communications with all elements of the group, including any associated submarines. This requires an effective and timely communications system between surface and subsurface ships. To ensure minimal degradation of submarine covertness, the system should have LPI and secure communication characteristics. The effort should also attempt to minimize constraints on the submarine's speed, depth, and course. The submarine also has the need to communicate with underwater swimmers.
Define and simulate selected techniques for communicating under water. Possible techniques include communications via ultraviolet wave lengths or via low frequency induction fields. The primary effort should emphasize ship/submarine communications, followed by the effort to provide communications with other platforms (e.g., underwater swimmers).

PHASE I: Address possible techniques, concept designs, signal and operational performance and trade-off studies.

PHASE II: Design and build engineering prototype for test and evaluation to demonstrate feasibility of the concepts.

PHASE III: Anticipate Navy sponsorship to transition into CSS.

N93-171 TITLE: High Dynamic Range Wide Band Receiver Front End

CATEGORY: Engineering Development; Digital Receivers, Digital Front End Signal Processing

OBJECTIVE: The development of a wide band front end module that converts radio frequency signals in the VLF to HF frequency range (3 KHz to 30 MHz) to a digital format. The module would interface with commercial available digital signal processor (DSP) modules to enable the quick design of new receive terminals.

DESCRIPTION: In Very Low Frequency (VLF) communications, the future progress possible in digital signal processing is now limited by the ability of receivers to convert analog signals to digital format over a large dynamic range (126 decibels or greater). Signal processing has been shown to be an effective method to compensate for a lack of transmitter power. Since it is desired to communicate over greater ranges from few sites, more signal processing is preferred.
Reconstruction of the communication signal in the presence of larger signals is also dependent on the amount of dynamic range available to the receiver. In cases where the communication signal is within a few dB of the noise floor of the receiver, signal reconstruction can be extremely difficult. The greater the dynamic range of the front end, the greater the interfering signals will have to be to disrupt communications.
Recent advances in digital signal processing have made it desirable to move the analog to digital conversion closer to the input of the receiver and to do less of the signal conditioning in the analog domain. A high dynamic range wide band receiver front end would permit the receiver to perform almost all of its signal processing in the digital domain and leave only the most rudimentary passband filters for the analog portion of the front end.

PHASE I: Phase I is a paper design of the receiver front end. Deliverables will include an analysis of intelligent gain control in the front end as well as the optimal way to maximize both bandwidth and dynamic range.

PHASE II: Phase II will be the construction of the receiver front end. Deliverables will include a working receiver front end and use, test, and maintenance manuals for the unit.

PHASE III: Anticipate Navy sponsorship to upgrade current VLF receive systems.

N93-172 TITLE: Artificial Intelligence (AI) for Command and Control

CATEGORY: Research; Machine Intelligence/Robotics

OBJECTIVE: Establish potential means of adding AI Battle Module optional modules on top of established Naval Tactical Command System-Afloat (NTCS-A), Operations Support System (OSS), and ASW Operations Center (ASWOC) architecture.

DESCRIPTION: NTCS-A is based on a federated architecture that has the Unified Build (UB) as its central component and has been adopted as the command, control, and intelligence support system for all echelons in the afloat environment. This same UB also forms the central component of the OSS at the CINC command centers and the ASWOC C3 Modernization program. Addition of an optional AI module to the established architecture at these nodes would assist in solving complex battle management problems and serve to enhance the overall C^3I effectiveness of naval forces ashore and afloat.

PHASE I: Assess the architecture of NTCS-A, OSS and ASWOC focusing on the UB and the extent to which it has the capability to support optional AI-based applications for battle management and tactical decision aids. Identify any architectural modifications necessary to more fully support AI-based battle management and tactical decision aids. Establish an abstract process model for AI-based tactical decision aids mounted on top of UB.

PHASE II: Using the results of Phase I, develop a proof of concept demonstration for an AI-based battle management application or decision aid mounted as an optional application on top of the UB. This application should use the tactical scene description contained within the UB as the basis for its decision process, and provide proof of concept for at least one of the following issues: scene understanding, complex (non-linear) scene projection into the future, plan development, plan assessment, execution monitoring and replanning.

PHASE III: Depending on the results of Phases I and II, implement the AI-based Battle Management and decision aid module for NTCS-A, OSS, and ASWOC.

N93-173 TITLE: Battle Group Tactical Decision Aid and Training Tool

CATEGORY: Exploratory Development; Data Fusion

OBJECTIVE: The Battle Group Commander must plan for, monitor, and manage his air, surface, and sub-surface forces to counter a wide variety of threats and contingencies in theaters ranging from open-ocean to shallow water regional conflicts. The objective is to provide a Battle Group Management tool to allow the Battle Group Commander to efficiently assimilate and evaluate large amounts of dynamic multi-dimensional data, and to perform situation assessment and resource allocation functions in real time. This tool also may be used for shore based or shipboard training, and for rapid communication of "lessons learned" from other Battle Group Commanders around the world.

DESCRIPTION: This SBIR Topic will investigate, identify, implement and demonstrate a prototype tactical decision aid and training tool. Major system components may include: (a) a virtual reality Operator-Machine Interface (OMI), (b) C^3I sensor inputs and communication links, and (c) a database management system and real-time and historical Battle Group database. Virtual reality OMI technologies to be investigated will include simulated 3-d wide field of view color displays (e.g., dome projection, goggles, helmet-mounted displays), data/power gloves, audio and/or gesture- sensing command and control, image processing techniques, and other innovative virtual reality concepts. Recent developments in database management (such as object-oriented databases) will be reviewed, and Battle Group database requirements will be developed. Emergent computer/software/ database technologies will be investigated for hosting and driving the virtual reality OMI and the database management system. All components will interface with existing and/or emerging C^3I communications technologies.

PHASE I: Determine technical merit by surveying state-of-the-art virtual reality OMI technology, C^3I communication links, computer processors, and database management systems. Identify options having the greatest potential for use in a Battle Group environment. Conduct tradeoff analyses and recommend an optimum prototype design for Phase II. Deliver a Technical Report documenting all work performed and results.

PHASE II: Investigate integration and database requirements for Battle Group applications. Implement and test a prototype system. Demonstrate the prototype using realistic "Battle Group scenarios and data." Deliver the prototype system and data, together with documentation, to the Navy.

PHASE III: Pending a successful Phase II outcome, navy sponsorship will be provided to transition into the C^3I community.

N93-174 TITLE: Molecular Density Storage Disk

CATEGORY: Exploratory Development; Semiconductor Materials and Microelectronic Circuits

OBJECTIVE: To develop a prototype data storage disk and a read/write head capable of storing up to one tera-byte of data.

DESCRIPTION: The data storage requirements for Navy Command and Control Operation Centers are rapidly surpassing the current technology in data storage capabilities. Due to the substantial increase in data coming from new and refined sensors, the operation centers are faced with massive amounts of data tapes which must be maintained and stored on site for historical reference. This effort is costly as far as the procurement of tapes goes and it is quickly becoming a serious floor space problem. Additionally, many command centers are now being required to go mobile and transporting large volumes of storage tapes is not conducive to this effort. A module is needed which allows data to be stored on composite disks by controlled patterning of molecules on multiple layers of the disk. This technique allows for a 4:1 reduction in size and a 1000:1 increase in data storage. A second to third module of the storage system that does not currently exist is the read/write laser head and the radiation hardened Application Specific Integrated circuits (ASICs) used for supporting the control and read/write/erase functions of the head. By using available disk technology and developing an efficient laser head device and controlling integrated circuit, an extremely useful system can be produced which will benefit both the military and commercial industry.

PHASE I: Provide a modular engineering design concept to include a steerable laser head for writing and reading data onto the disk, disk material make-up and overall system design.

PHASE II: Provide demonstration modules which implement the elements of Phase I.

PHASE III: The results of this development will benefit DoD sites worldwide as well as the commercial sector.

N93-175 TITLE: SHF Array Antenna

CATEGORY: Exploratory Development; Signal Processing

OBJECTIVE: To develop a stacked phased array SHF antenna which is easily transportable, easily deployable and has no moving components.

DESCRIPTION: The SHF antenna designs of today are cumbersome, mechanically controlled and poorly suited for mobile applications. Additionally, a single antenna must be rotated in order to communicate with different suers in varying locations. A stacked, phased array SHF antenna can handle multipl› users in varying locations (without rotating) and at the same time provide an increase in signal strength gain. In order to meet the requirements of rapid deployment units, the antenna must be collapsible and quickly deployable.

PHASE I: Develop the hardware design and materials list which meets the stated objective.

PHASE II: Provide a demonstration prototype which can meet the requirements listed in the description section.

PHASE III: Results of this tasking will lead to a final design which will support requirements of DoD command and control nodes.

N93-176 TITLE: C^3 Computer Assisted Communications

CATEGORY: Research; Signal Processing

OBJECTIVE: Design, model and prototype a computer-assisted, user-friendly, multi-function communications control system which optimizes the use of all available media (point-to-point and/or the entire radiated frequency (RF) spectrum) to establish virtual voice, data, facsimile or imagery connectivity between users.

DESCRIPTION: Within the context of the Copernicus command, control, communications, computers and intelligence (C4I) architecture, CNO has mandated that communications connectivity be "virtual" (e.g., specific RF or point-to-point media should be invisible to the user; the ability of users to "pull" information from available sources in a timely manner is the principal criterion). An innovative approach is required to design and prototype a computer-assisted communications control system which meets the following criteria: small, lightweight, mobile, with minimum input power requirements; modular "plug-in" board components of VME and FutureBus design housed in standard chassis, which run applications software under DOS and UNIX, and have the capability to download and process software and data transmitted from a remote site. (Boards must be compatible with, and compatible in power to, DTC-2, TAC-3 and 486 PC computers); features high-speed, fiber optic 4X4 to 16X16 port photonic switch connectivity to enable operation of remote, unmanned communications sites; includes >64KB digital packet switching in an asynchronous transfer mode (ATM) network to enable broadband services (such as video teleconferencing); features a user-friendly workstation wherein voice, data, facsimile or video can be selected; data compression, encryption, selection of wideband or narrowband; and provide an aggregate output to allow for bandwidth on demand.

PHASE I: Provide potential designs, trade-off analyses, and where possible, demonstrations of proposed technology.

PHASE II: Develop a working model of the computer-assisted communications system. A detailed comparison with presently available equipment is essential.

PHASE III: Develop a prototype of the system. Anticipate significant DOD interest upon successful prototype testing.

N93-177 TITLE: Passive Remote Sensing of Meteorological Parameters

CATEGORY: Exploratory Development; Passive Sensors

OBJECTIVE: To develop surface based passive remote sensing techniques to obtain vertical profiles of meteorological parameters.

DESCRIPTION: Meteorological support is a vital requirement for the planning and execution of virtually every aspect of Naval warfare. This support is often critically dependent on the ability to accurately measure local atmospheric parameters

in real time. These parameters include inter alia, temperature, wind speed and direction, humidity and aerosol content. Currently, balloon or rocket borne sounders are used to obtain data remotely, and LIDAR techniques are under development to acquire vertical profiles of these parameters. The disadvantage of these active systems is that they radiate electromagnetic or electro-optic energy subject to enemy detection. In addition, personnel safety and space requirements may be important issues, especially in shipboard environments. Passive surface based sensors are an attractive potential alternative.
Innovative new technologies are sought which can provide a capability to passively measure meteorological parameters in both marine and overland environments. Proposed devices must be able to provide vertical meteorological parameters up to several thousand meters altitude with a resolution of 100 meters or better. Systems should be capable of day and night operations in a wide range of weather conditions.

PHASE I: This six month effort should produce an evaluation of technologies which may lead to a ground based passive remote sensing capability to measure vertical profiles of at least one meteorological parameter.

PHASE II: A two year effort to complete development of the proposed instrument, including a performance demonstration which will confirm the accuracy and capability expected from the fielded system.

PHASE III: A Phase III effort is planned.

NAVAL SUPPLY SYSTEMS COMMAND

N93-178 TITLE: Commercial Pallets for Cargo Transfer at Sea

CATEGORY: Engineering Development; Weapons System Environment

OBJECTIVE: Eliminate need for special "winged" pallets in CONNECTIVE underway replenishment of weapons systems items at sea for cost and operational gains.

DESCRIPTION: When transferring weapons systems spare/replacement parts, consumables, and other items from a replenishment ship to another ship, the two ships steam alongside on parallel courses while linked with a cargo transfer rig by which unitized pallet loads are transferred. Pallets are suspended from the rig with slings which hook under protruding ends of top boards or "wings" of the pallets. To date, no other means of lifting the pallets has been devised; this single mandatory requirement results in the entire military establishment using special "winged pallets" to accommodate the possibility that any particular pallet load will eventually need to be transferred at sea by the underway replenishment method described above. Alternative means using standard commercial pallets must be developed that are at least as fast as the current method, and if possible, safer. Work will include providing means for continuing use of "winged" pallets until phased out of use and for accommodation of the several types of commercial pallets now in use and being proposed and/or developed; this includes accommodation of the several types of commercial pallets currently being considered/proposed for use as a national standard default pallet. These references can be obtained from NAVSUP: NWP-14D, "Underway Replenishment at Sea"; NAVSEA OP2173 Volumes 1 and 2, "Approved Handling Equipment for Weapons and Explosives".

PHASE I: Become knowledgable about current connective underway replenishment procedures and all types of pallets now in use or anticipated for use, including site visits to one East Coast fleet logistics base, and other means, as appropriate. Submit a report on proposed feasible alternatives to accomplish the desired improvements.

PHASE II: Navy selection of one of the proposed alternatives for development of a complete engineering study for one of several types of underway replenishment rig configurations. The work will include detailed drawings of the proposed design complete with data on strength testing and design computations. Fabricate and test the device on the selected type of rig configuration during actual replenishment at sea or at a land based test site.

PHASE III: Fabricate several devices for each of the several types of underway replenishment rig configurations. These devices will then be tested at [illegible] during actual underway replenishment. Make modifications to fabricated devices as necessary to ensure that a final design will achieve the desired objective of this research. The work will include development and submission of 100 percent design drawings and specifications for follow-on procurement of transfer devices for all replenishment ships of the Navy.

N93-179 TITLE: Streamlined Requisitioning of Ammunition

This topic is CANCELLED.

N93-180 TITLE: Computer Aided Prediction Tool for Parts Obsolescence Management

CATEGORY: Exploratory Development; Computers

OBJECTIVE: To develop, demonstrate and test a Navy wide relational database for prediction of parts obsolescence management.

DESCRIPTION: Develop or enhance relational database software, on commercially available computer hardware, to provide the Navy a predictive tool that will allow for the planning, management and cost avoidance in the area of electronic and mechanical parts obsolescence. Current systems exist that provide limited predictive capabilities in a specific electronic area (microcircuits). Obsolescence prediction tool survey Analysis, of 20 August 1992 is available upon request via the NAVSUP point of contact. Those systems should be research for feasibility, and effectiveness, and integrated into a comprehensive Navy prediction tool. Attributes of the system should include at a minimum; (1) Break-out of the components by technology, function, manufacturer, packaging requirements, suppliers; (2) Identification of alternate sources; (3) Depict or minimize the use of single source vendors; (4) Provide an "alert notification" or access to an alert notification system, (5) Has or can integrate or develop a complete list of electronic and mechanical components used in U.S. military weapons systems; (6) The system should be remotely accessible through electronic or by magnetic tape; (7) The system is to be "user friendly".

PHASE I: Explore the feasibility of a Navy wide integrated predictive tool. Make an assessment of applicable existing predictive tools and develop predictive models where currently not available to cover the wide spectrum of electronic and mechanical parts. Develop and demonstrate a "laboratory" model of this prediction system. Prepare a final report that documents all Phase I efforts and criteria for the development of the prototype system. Travel to various Navy Weapon Center Divisions (i.e., Keyport, WA, Crane Indiana) and commercial vendors (east and west coast) will be required.

PHASE II: Develop, test and evaluate an obsolescence tool which has the capabilities described above in Phase I, for use in Navy Headquarters facilities and field activities. Preparation of a documentation package, a users guide and formal training to several Navy activities on the system will be required deliverables.

PHASE III: If Phase II is successful, Phase III will include additional multiple users and follow-on training.

NAVAL CIVIL ENGINEERING LABORATORY

N93-181 TITLE: Novel Methods of Paint Removal from Wood, Concrete or Steel Substrates

CATEGORY: Exploratory Development; Composite Materials/Simulation and Modeling

OBJECTIVE: Develop a method of removing existing paint systems that would produce minimal debris and dust, but still have moderate to high productivity.

DESCRIPTION: Current methods for the removal of existing paint
systems either produce large amounts of dust and waste or have a low production rate. With the development of strict regulations governing air pollution and disposal of wastes, many existing paint removal practices will no longer be cost effective. Generation of dust and hazardous waste is also a major health and safety concern in the removal of lead-based paint. A technique is needed that would effectively remove paint from various substrates while producing the least amount of debris and dust. (funding for this Phase I topic will not exceed $50,000)

PHASE I: A detailed report shall be produced which describes the method and provides sufficient scientific and engineering.
substantiate its feasibility. Technologies identified must show the potential to be more efficient than current industry practices in terms of debris, dust and hazardous materials generated and the rate of removal. A test plan shall also be developed for demonstrating the technique in Phase II.

PHASE II: Develop, test and evaluate the method identified in Phase I. The candidate method shall demonstrate the capability of
removing paint from wood, steel or concrete in a manner which produces less dust and debris than existing paint removal techniques. A moderate to high rate of removal shall also be maintained.

PHASE III: Phase III effort is anticipated to take advantage of the results of Phase I and Phase II through the commercial sector.

N93-182 TITLE: Repair of Reinforced Concrete Piers

CATEGORY: Exploratory Development; Composite Materials

OBJECTIVE: Identify failure mechanisms, methods, and materials to increase longevity of sub-structure repairs to reinforced concrete structures to 20 years or more.

DESCRIPTION: Corrosion of the reinforcement is the most common form of degradation. The underside of existing structures are often contaminated with chloride ion and moisture to a severe level resulting in intense local corrosion cells. The most severe problem occurs on the underside of the deck, pile caps, beams and piles in the splash zone. The top of the deck is often not damaged or contaminated to the threshold, hence macro-cell corrosion is also likely. Current repair methods to remove and replace debonded concrete have a life expectancy of 2-20 years. NCEL has identified four topics for investigation: cathodic protection systems, mechanisms of de-bonding, maximum allowable shrinkage of repair materials and quality control. (funding for this Phase I topic will not exceed $50,000)

PHASE I:

A: Evaluate the applicability oı adopting or adapting current cathodic protection systems used on highway bridges to the underside of Navy pier decks over the ocean. Both anodic and impressed current systems shall be considered. Design an investigation to establish the feasibility of constructing an effective and durable cathodic protection system for substructure application.

B: Propose a mathematically model to predict life expectancy of a restrained cementitous repair material as a function of shrinkage, temperature and creep. Life expectancy is defined as the time before stresses at the bond results in debonding. Design an experiment to validate the model.

C: Propose quality control methods which will increase longevity of sub-structure repairs that are applicable to Navy contract and inspection procedures. Design a task to develop the proposed methods.

PHASE II:

A: Conduct an investigation to establish the feasibility of constructing an effective and durable cathodic protection system for substructure application.

B: Verify the mathematically model to predict life expectancy of a restrained cementitous repair material as a function of shrinkage, temperature and creep in laboratory tests.

C: Develop quality control methods which will increase longevity of repairs to a 20 year life.

PHASE III: Further development and demonstration of performance is required but is function of available Navy funding.

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER (NPRDC)

N93-183 TITLE: Hypermedia for Training

CATEGORY: Exploratory Development; Training

OBJECTIVE: To explore the use of hypermedia to increase the efficiency and effectiveness of Navy training.

DESCRIPTION: Hypermedia is a technology for organizing discrete chunks of information in a non-technical manner. A chunk of information might be represented as text, sound, pictures, animated graphics, or video. Any chunk of information can be linked to any other within a hypermedia application. Hypermedia is a versatile software tool because it can manage multimedia, is easy to use, and is flexible. Given its versatility, hypermedia may have potential as an instructional delivery system particularly in instances where an abundance of declarative information is required to be learned or where learners are required to link information in a meaningful way. However, the use of hypermedia as an instructional delivery system requires more theoretical research and technical development (Park, 1991). Critical areas of hypermedia research include the effects of learner control, form of information presentation, and organization of knowledge base. (funding for this Phase I will not exceed $50,000)

PHASE I: Explore the feasibility of using hypermedia as an instructional delivery system. Investigate its potential in learner control, form of information presentation, and organization of knowledge base.

PHASE II: Develop a software program which can be used to create experimental hypermedia-based training. Employ this software to create training for the declarative knowledge requirements of the General Electric LM2500 Gas Turbine Engine. Empirically evaluate the effectiveness of the training.

PHASE III: Pursue the development of a generic software which enables the design and development of hypermedia training.

N93-184 TITLE: Identification of Knowledge Structures Underlying a Task Process Model

CATEGORY: Exploratory Development; Training

OBJECTIVE: To develop a methoa for identifying knowledge structures that underlie the procedures for performing a task.

DESCRIPTION: One type of model that can be developed for a particular job or task is a process model in the form of a flow chart. However, this approach concentrates on procedures as opposed to knowledge. Once the process model is constructed, it could be enhanced by identifying underlying knowledge structures that are related to critical procedures in the process model. Several methods exist for knowledge elicitation; for this effort, the starting points for developing the knowledge structures are critical procedures in the process flow model. (funding for this Phase I will not exceed $50,000)

PHASE I: Develop a method for identifying knowledge structures underlying a process model of a particular task or job. Both the acquisition of the knowledge structures and their representation should be specified. The method should be as parsimonious as possible and relatively easy to apply by someone who is not a knowledge engineer.

PHASE II: The method developed in Phase I will be applied to two content domains and evaluated. Two forms of evaluation would include the method for acquiring the knowledge and the form of the knowledge structure itself.

PHASE III: A generic form of the model will be explored for development as a software package.

N93-185 TITLE: Software Development for Linking Cognitive Styles with Instructional Strategies

CATEGORY: Exploratory Development; Training

OBJECTIVE: Develop methods to assess learners' possession of cognitive styles and their relationship to performance; investigate inclusion of cognitive styles as a component of a student model in an intelligent tutoring system.

DESCRIPTION: Cognitive style, as a component of learner aptitude, impacts learning and operator performance. Even though specifications for tailoring instructional treatments to aptitudes have been known for some time, to date the differences among learner aptitudes could not be handled effectively or practically in the military training environment. Now, with the advent of intelligent tutoring systems, and sophisticated software potential, we may have the vehicle to address the role of cognitive styles in learning and performance. (funding for this Phase I will not exceed $50,000)

PHASE I: Examine the inclusion of cognitive styles into a dynamic student model, and the tailoring of instruction to those aptitudes in an effort to decrease training time and increase skill and knowledge retention and performance; explore the feasibility of developing a means to assess cognitive style.

PHASE II: Incorporate cognitive style into a dynamic learning model which matches instructional strategies to individual cognitive style. Development cognitive style assessment tools.

PHASE III: Explore the adaptability of the cognitive style/instructional strategy model to various computer systems.

N93-186 TITLE: Modeling Electronic Warfare (EW) Operator Performance

CATEGORY: Exploratory Development; Training

OBJECTIVE: To develop a model of EW operator performance that could be used for training/diagnostic purposes.

DESCRIPTION: EW operators require refresher training at regular intervals to maintain their skills. Currently, most refresher training is provided on a scheduled periodic basis, without regard for the actual status of the operator's skill level. The train EW operators receive should focus on the areas that will show the most significant gains in overall performance/effectiveness, as well as the areas that are most likely to degrade during routine operations. The purpose of this effort is to develop a model of EW operator performance that could be used to identify the most beneficial training, and

could also predict the areas most likely to become degraded. (funding for this Phase I will not exceed $50,000)

PHASE I: Analyze available modeling software and identify the most appropriate for this application. Develop a model of EW operator performance, specifying operator tasks and decision branches to at least three levels, using the identified software.

PHASE II: Obtain the performance data necessary to validate the model developed in Phase I.

N93-187 TITLE: New Techniques to Assess Learning Retention

CATEGORY: Exploratory Development; Training

OBJECTIVE: Develop techniques to assess learning that are superior to traditional pencil and paper tests.

DESCRIPTION: Many Navy jobs are very complex. It is often very difficult to determine when a trainee is really competent to perform on-the-job. Traditionally, trainees are judged to be ready for graduation from a training course when coursework is complete if the average grade from periodic testing are above a predetermined criterion level. Grades are most often determined through paper and pencil testing, although performance on simulated tasks may also be graded. This system is far from perfect because it is based upon the assumption that memory for facts and figures is correlated with performance. Indeed, memory is correlated with performance, but the correlation for any particular job may be rather low. In the classroom environment, performance testing may not be possible because of resource, technological, and safety restrictions. Alternative methods to estimate learning and retention of complex skills and knowledge could improve assessment in many job specialties. (funding for this Phase I will not exceed $50,000)

Phase I: It is known that learning results in long-term changes in the brain which can possibly be assessed using modern neuroscience techniques. One measure that has been shown to reflect changes in the brain structure and function is the event-related potential (ERP). In the standard paradigm, individuals are exposed to a stimulus that is presumed to be related to the function being measured. Brain electrical or magnetic activity is recorded just prior to, and following, the stimulus. The shape of the waveform that is recorded is affected by the perceptual, cognitive, and motor processes associated with the task. Previous research has suggested that semantic knowledge can be reliably assessed using these techniques. The purpose of this research would be to identify and develop specific ERP techniques to assess knowledge and skill, and demonstrate that these techniques can reliably assess knowledge and skill for a subset of tasks similar to a specific Navy job.

Phase II: Once the techniques have been developed and assessed, it will be necessary to evaluate their usefulness in a Navy population. This would involve trainees in a technical training course. Initially, the work would involve the selection of the skill and knowledge domain to be used in the evaluation. It is anticipated that performance tests would have to be developed if they do not already exist. Once the domain is selected, trainees would be evaluated periodically during training.

PHASE III: Commercialization to other government and private sector areas.

N93-188 TITLE: Signal Processor for Operational Biopsychometric Assessment

CATEGORY: Exploratory Development; Simulation

OBJECTIVE: Design and develop a compact, rugged, and portable signal processing system for operational recording, storage, and real-time processing of brain electrophysiological measures.

DESCRIPTION: The combat systems of the future will take advantage of adaptive algorithms for real-time enhancement of human operator performance. Depending on the inferred cognitive state of the operator, the system will modify its characteristics---interface, workload, level of automation---so as to maximize the combat effectiveness of the operator. Research has shown that biopsychometric techniques based on EEG and event-related potentials (ERP) provide information about the cognitive state of human operators in laboratory simulations of Navy combat systems. EEG measures provide indices of alertness in vigilance tasks such as sonar monitoring. ERP measures index operator workload and can predict performance in resource-limited tasks such as electronic warfare. Other research has shown that biopsychometric techniques may also allow for real-time monitoring of cognitive state in aviators. In addition, biopsychometric methods will have impact on simulator-based training, by adapting the training protocol to the current ability of the trainee. (funding for this Phase I will not exceed $50,000)

PHASE I: Implementation of biopsychometric methods will require a new generation of hardware and software for data acquisition and processing. In Phase I, studies and designs are invited for compact, rugged, and portable systems for operational EEG data acquisition and signal processing. Such systems must address three fundamental technical problems: (1) Standard electrode assemblies which are minimally obtrusive, easily attached in a few minutes by operational personnel, require no adhesives or special electrolyte compounds, and provide adequate signal-to-noise ratio for recording the EEG, (2) real-time signal processing capability which allows for analog amplification, anti-alias and notch filtering, as well as for digital processing including ensemble averaging, digital filtering, spectral analyses, multiresolution analyses or sub-band coding, and wavelet transforms. The system must be able to apply such algorithms to multi-electrode EEG data obtained at data rates of about 10K samples per second, obtain results, and supply them to the system for use in adaptive algorithms within a 30-second window of acquisition time, and (3) large storage capability suitable for recording for several hours of unattended operation at data rates of 10,000 samples per second or approximately 300 megabytes. Such storage should be resistant to operational hazards such as electrical or magnetic fields encountered on ships and aircraft.

PHASE II: Prototype signal acquisition/processing systems will be developed and evaluated in candidate Navy operational tasks including sub-surface ASW and surface EW. Navy laboratories using biopsychometric technology will perform the evaluations and provide feedback to designers as required. A final design will be targeted for advanced development and procurement.

NAVAL AIR SYSTEMS COMMAND

N93-189 TITLE: Passive vs Active Fly-By-Wire/Fly-By-Light (FBW/FBL) Electronic Flight Controller

CATEGORY: Engineering Development

OBJECTIVE: To develop an acceptable architecture, proof -of-concept, prototype design and flight test evidence leading to a production configuration for a replacement for a tilt rotor aircraft cyclic stick controller and foot pedal combination.

DESCRIPTION: A side-arm or center stick electronic controller will reduce the weight of the V-22 aircraft and improve aircraft handling qualities. A passive controller will provide significantly greater weight reduction over an active system. However, an active controller may provide better aircraft handling qualities than a passive system but with much greater complexity and size.

PHASE I: A study will determine which combination of side-arm vs. center stick and passive vs. active configuration of electronic controllers will provide the best configuration and weight reduction standpoint. A detailed and comprehensive survey of all existing military and commercial fixed- and rotary-wing aircraft utilizing center-stick and/or side-arm controllers will be included.

PHASE II: A prototype system will be developed and laboratory tested in the V-22 FCSIR and flight tested as a back-up system to the cyclic stick mechanical controller and foot pedals currently on the V-22.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-190 TITLE: Generalized Study of Avionics Architecture/Bus

This topic is CANCELLED.

N93-191 TITLE: High-Speed Opto-Electronic Processing

CATEGORY: Engineering Development: Parallel Computer Architecture

OBJECTIVE: To develop an integrated approach to opto-electronic devices and systems for implementation of high-speed processing architecture. State-of-the-art technology should be used to reduce power, size, and weight, and greatly increase the speed of processors used on-board navy advanced tactical aircraft such as the V-22. The process is intended to improve the computing capabilities for command, control, and communications of tactical aircraft and space-based assets.

DESCRIPTION: Advancing optical technology is producing an assortment of devices and system components suitable for

interconnecting electronic chips which can significantly impact the speed and compactness of processors. Examples are semiconductor modulator and microlaser devices, micro-optic, free-space and waveguide interconnection media. Integration of opto-electronic, electronic, and micro-optic components on a substrate and the optical interconnection of multichip modules thereof is highly desired.

PHASE I: The result of the PHASE I study will be a design for configurations of electronic, and classical optical components which are mutually compatible and can be implemented into an opto-electronic processing architecture.

PHASE II: The results of this effort will produce a working prototype opto-electronic integrated circuit suitable for opto-electronic processing architectures.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-192 TITLE: Avionics Architecture/Data Bus Configuration

CATEGORY: Engineering Development; Parallel Computer Architecture

OBJECTIVE: Evaluate the contributions of avionics architecture/data bus configuration to data latency.

DESCRIPTION: The Navy must optimize avionics architectures/data bus configurations so that data latency is limited and system performance is maximized.

PHASE I: This effort will provide recommendations on methodologies and techniques that can be implemented to minimize data latency for single-level, multi-level, and hierarchical data bus architectures. Factors to be considered will include gap/response/interrupt times, processing algorithms, synchronization, message type/ordering/framing, and data formatting. In addition, adjustments and cost to existing systems required will be identified to attain optimum architecture.

PHASE II: A breadboard control and display system will be built and appropriate software developed using simulated avionics interfaces and demonstrated in a mature military aircraft systems integration lab (SIL).

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-193 TITLE: Tilt Rotor Aircraft Portable Landing Aid System

CATEGORY: Advanced Development; Weapon System Environment

OBJECTIVE: To develop a conceptual design for a portable landing aid system which would take maximum advantage of tiltrotor aircraft VERTOL/VSTOL capabilities.

DESCRIPTION: The development of the MV-22 tiltrotor aircraft holds the promise of performance not previously achievable with rotary wing aircraft. Increased range and speed, enhanced load capacities, and a much reduced noise profile (blade slap) will allow the development of significantly more ambitious and aggressive SOF mission profiles. Covert, all weather personnel/equipment insertion and extraction capabilities would be greatly enhanced by the development of a low probability of intercept (LPI), portable landing aid system (PLAS). The system design should take full advantage of MV-22 VERTOL/VSTOL capabilities and provide precision guidance to touchdown or hover at/over a desired ground point.

PHASE I: PHASE I study would include the following elements:

a) Review of projected V-22 mission profiles to determine PLAS capture window requirements.

b) Review of V-22 VERTOL/VSTOL approach and landing profiles to determine PLAS operating windows (i.e., +/-X degrees in azimuth and elevation) and/or modes (i.e., flat approach, steep approach, landing, or hover).

c) Determine ability of air crew to track precision landing aid with V-22 to define PLAS glide path and glide slope resolution requirements for the V-22 approach profiles identified above.

d) Identify PLAS power and antenna pattern requirements and assess LPI characteristics.

e) Develop conceptual PLAS design.

PHASE II: PHASE II will involve the development, test, and demonstration of a prototype PLAS system.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-194 TITLE: Expeditionary Airfield Soil Stabilization

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Develop and evaluate an environmentally safe soil stabilization compound which will eliminate the effects of soil micro-fod on turbine engines and the leading edges of prop/rotor blades.

DESCRIPTION: Need exists for stabilizing the soil in the immediate vicinity of where AM-2 matting is laid at Expeditionary Airfields due to the effects of soil micro-fod. During Desert Shield/Desert Storm, numerous cases of premature turbine engine degradation and prop/rotor blade erosion were documented due to the effects of soil micro-fod. Upon IOC of the MV-22, it is considered that this problem will be further exacerbated due to the MV-22's increased rotor downwash. Based on documented cases, the effects of soil micro-fod on the MV-22's engines and prop/rotor system will substantially reduce the service life of these components.

PHASE I: Explore and evaluate available soil stabilization compounds based on effectiveness, cost/unit, method of application, shelf life stability, and environmental compatibility.

PHASE II: Test available compounds at an Expeditionary Airfield in order to determine suitability.

PHASE III: The topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-195 TITLE: Expeditionary Lighting

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Develop and evaluate a light-weight, expeditionary lighting system, comparable to the GAIL light system, that will facilitate day/night unaided and Night Vision Goggle (NVG)/ Forward Looking Infrared Radar (FLIR) approaches to landing. This system shall include a NVG/FLIR compatible VASI.

DESCRIPTION: Current expeditionary lighting is outdated, unreliable, and is not compatible with NVG/FLIR systems. Consequently, aircraft forward basing can not be effectively executed with a comfortable margin of safety. With a suitable and compatible lighting system, the MV-22 would be able to operate from forward expeditionary sites with an increased margin of safety.

PHASE I: Explore and evaluate available lighting systems based on effectiveness, cost/unit, compatibility with night systems NVG/FLIR), cube, weight, deployability, and commonality with other services' lighting systems.

PHASE II: Test available lighting systems at an Expeditionary Airfield in order to determine suitability.

PHASE III: The topic has the potential for transition to PHASE III via linkage between the small business and V-22 prime contractor and/or component suppliers.

N93-196 TITLE: Interactive Embedded Training System for Military and Commercial Aircraft

CATEGORY: Advanced Development; Simulation and Modeling and Software Producibility

OBJECTIVE: To develop a method for constructing interactive on-board, artificially intelligent training system for pilot and crew tasks that is portable, robust, high-fidelity, and constructed of reusable components. The benefits of this effort will include (1) increases in a pilots situational awareness and overall system knowledge and (2) a software and hardware infrastructure that can integrated with advanced on-board mission processors for developing health and usage monitoring systems.

DESCRIPTION: Currently, all aircraft flight system and performance analyses are conducted using airworthy qualified flight manuals. As aircraft and their systems become more complicated, the manuals become more cumbersome and are difficult to use in a classroom environment. Recently, many manuals have been reduced to electronic flight manuals (data files) which can be read and manipulated by desktop or portable computer systems.

By embedding intelligent training and flight software within these electronic flight manuals, it is possible to develop a comprehensive interactive learning aid complete with instructional lessons, multi-media video and sound systems, and network capabilities.

The production of such portable, high fidelity, intelligent training systems requires the development of object oriented dynamic link libraries, object linking, and embedding modules. This technology permits easy access to relational databases while presenting video lectures, comprehension testing, help commands, and tutorials. It is anticipated that a Windows-compatible environment will make it possible to develop a generic embedded software training tool that an be used in a wide variety of military and commercial aircraft.

A key feature to the success of wide scale production of such training systems is the development of generic aircraft flight prediction algorithms that which significantly reduce data storage and processor requirements. Advanced mathematical techniques will be merged with theory and flight test data to develop a continuous equation set which completely defines the aircraft operating state.

PHASE I: The primary activities during Phase I will be (1) the development of systems requirements for the portable, intelligent, multi-media training systems and (2) the construction of the generic aircraft flight prediction algorithms. The contractor will work with NAVAIR to identify target aircraft and training scenarios of importance to the NAVAIR mission. The deliverable for Phase I will be a technical report specifying alternative systems architectures with recommendations and the generic aircraft flight prediction algorithms.

PHASE II: During Phase II the contractor will produce a prototype training system based on the selected architecture identified during Phase I. The prototype will use the generic aircraft flight prediction algorithms developed during Phase I and will train pilots and crew for an aircraft central to the mission of NAVAIR.

PHASE III: Navy funding is anticipated for Phase III activities.

N93-197 TITLE: Computer-Based Training For Corrosion Control

CATEGORY: Research; Computers

OBJECTIVE: Develop and demonstrate CBT interactive course (ICW) for basic corrosion control training for use on stand alone IBM compatible PC computers for all military services.

DESCRIPTION: This requirement is for the utilization of state-of-the-art development in ICW technology specified in DoD specifications and standards to instruct and train personnel in the recognition, correction, treatment, and prevention of corrosion. Appropriate areas for consideration might include, but are not limited to: aircraft, vehicles, ships, and electronic equipments.

PHASE I: Identify training package concepts, methodology, and tools required by MIL-HDBK-284-1 and MIL-STD-1379D by conducting an evaluation of existing commercial authoring packages and/or developing a limited customized software package.

PHASE II: Purchase and test computer software identified in Phase I and develop, demonstrate, and deliver prototype corrosion control training models using these software packages.

PHASE III: Some parts of this program may have commercial use.

N93-198 TITLE: Development of a Direct Manipulation Interface for Real-Time Demonstration of Simulated Flight Training Scenarios

CATEGORY: Exploratory Development; Simulation and Modeling and Machine Intelligence

OBJECTIVE: The objective of this project is to develop a Direct Manipulation Interface that will allow trainers to configure, in real time, training scenarios for individual and crew training. Benefits include (1) extremely rapid configuration of training scenarios and (2) the ability to reconfigure training in real time.

DESCRIPTION: Design of individualized training exercises for pilots, missile control crews, and the like is a very costly, and time consuming activity which requires the interaction of many people, including trainers, programmers, and engineers. In order to be able to respond more quickly to the training needs of individuals, it will be necessary to provide trainers with a way to quickly build training scenarios without the assistance of programmers, engineers, etc.

This project will focus on the development of the requirements and specifications for a virtual reality based Direct Manipulation Interface (DMI) authoring system for real-time construction of flight training scenarios. The DMI should permit a trainer to simply reach into the virtual reality to configure training scenarios. Behind the scenes program generation software will interpret the trainer's design, search a library of reusable software and hardware components, and

configure the training scenario automatically in a matter of seconds or minutes. In addition, the DMI should permit trainers to alter training scenarios as they unfold in real time. Proposals with NAVAIR user endorsements will be given special considerations. This project will have three phases.

PHASE I: During Phase I, the contractor will perform analyses of a subset of the domain of training scenarios that is of interest to specific branches of NAVAIR. This phase will identify (1) the hardware and software components that will have to be specified to develop the libraries of reusable components, (2) develop a description of a virtual reality based DMI that will allow trainers to develop training scenarios in real time, and the hardware and software specifications for the DMI will be given. The deliverables for Phase I will be a written report covering (1) and (2) above and a plan for Phase II.

PHASE II: During Phase II, the contractor will develop a significant prototype virtual reality based DMI for constructing training scenarios. The selection of the domains of the prototype will be performed in conjunction with NAVAIR. The prototype will handle two training domains. The deliverables for Phase II are (1) the prototype and (2) a demonstration of commitment to produce the full scale tool.

PHASE III: This is commercialization phase. A fully operational virtual reality based DMI for constructing training scenarios will be developed. NAVAIR may be interested in becoming a beta test site to provide government/user feedback into the commercial market.

N93-199 TITLE: Alternative Motion Systems for Interactive Flight Simulation Systems

CATEGORY: Exploratory Research; Simulation and Modeling

OBJECTIVE: To investigate new motion base technology in order to determine a low cost motion simulation alternative for interactive simulator systems.

DESCRIPTION: Today's military flight simulation systems require a high fidelity not only in the visual system, but also in the motion system as well. Where customers of visual systems have enjoyed the benefits of falling prices and higher technology, typical in today's computer market, the same cannot be said for the motion systems market. The traditional motion system requires a large reaction mass in addition to a complex and massive hydraulic system . In order to induce realistic sensations of motion to match the ever improving visual simulation, extremely large investments must be made by the customer, not only for the motion system itself, but also in the military construction associated with housing such a sizable device. In addition to the extremely high cost of procurement, the traditional motion base system also carries with it, high life cycle maintenance cost. With ever decreasing DoD budgets, it is imperative that more cost effective solutions be found.

There is now evidence in the commercial industry of potential cost effective alternatives to traditional motion systems. Recent advances in hardware and software technology warrant the assessment of alternative motion systems technology to provide innovative , cost effective solutions to DoD as a whole.

PHASE I: During Phase I the contractor will investigate the feasibility of alternative motion base technology as it is applicable to DoD (Navy and Marine) real world flight simulators and produce a final technical report.

PHASE II: During Phase II, the contractor will design and develop a prototype system, based on the requirements specified in the efforts of Phase I.

PHASE III: Upon successful completion of Phase II, Navy funding is anticipated for limited production of the prototype .

N93-200 TITLE: Risk Reduction Management System

CATEGORY: Advanced Development; Simulation and Modelling

OBJECTIVE: Provide a high level management tool to enable the Program Office to use the results of technical analyses to manage program risks.

DESCRIPTION: Provide a system to consolidate results from the following into an interactive data base: environmental analyses, system operational analyses, threat inputs and tactical modelling. The system should define formats for the basic analysis results and provide capability for the program office to explore "what if" questions not necessarily addressed in the underlying analysis. This system will be used to manage program risks in the Program Office.

PHASE I. Identify hardware and software available to develop a risk management system and provide a

development plan for building the system including a preliminary description of the architecture you would use to develop the system. The data consolidation is to be accomplished at Navy laboratories, and the risk management tool is to be installed in the project office.

PHASE II: Build and test a prototype of the risk management system defined in Phase I.

PHASE III: Implement lessons learned in Phases I and II and install operational system in the Project Office (PMA-264) and in one Navy laboratory (laboratory to be named by the Project office).

N93-201 TITLE: JTIDS/MIDS Displays Optimization

CATEGORY: Engineering Development

OBJECTIVE: The objective is to determine the optimum display size and information type for the pilot using JTIDS/MIDS.

DESCRIPTION: JTIDS/MIDS provides the means for a fighter aircraft to transmit/receive a great deal of information to/from other fighters and Command and Control (CC) platforms. However the amount of information available to the operators can be overwhelming. The physical display size and the shape, intensity, color and size of the symbols are important parameters in the optimization of the operator/machine interface during high data rate environments.

PHASE I: The study will research, model, and document answers to the following questions: (1) What is the optimal physical display size for a system like JTIDS/MIDS?, (2) What is the best symbol set?, (3) What is the right number of symbols?

PHASE II: Several aircraft will be involved with JTIDS/MIDS. The cockpit architecture is different for each aircraft. This phase will determine the best match between the optimum display and symbol set found in phase I and the available resources in the various aircraft.

PHASE III: Symbol set characteristics will be optimized for each platform type. As cockpit upgrades occur, the JTIDS/MIDS requirements will be taken into account. The operator/machine interface efficiency will be known for the existing display sizes. Knowing this efficiency will aid in tactical decisions and network performance.

N93-202 TITLE: ADA Software Reliability Measurement Tools

This topic is CANCELLED.

N93-203 TITLE: Software Code Translation From Assembly to Ada

This topic is CANCELLED.

N93-204 TITLE: Bar Code Implementation for F/A-18 Production and USN Field Accounting

CATEGORY: Engineering Development;

OBJECTIVE: The objective is to assist in inventory control, failure tracking, a warranty control, and defect prevention by accurately tracking Weapon Replacement Supplier (WRA) locations and critical parameters from WRA supplier to Prime Contractor to the Fleet by utilizing a universal Bar Code Information System. The "bar code" plan and database requirements will be used at the Prime Contractor and at the WRA Supplier to reduce cost and approach 6 sigma quality.

DESCRIPTION: Providing an affordable WRA history throughout the life the WRA has the potential of significant cost avoidance for the industry as well as the U.S. Navy. Confirmed as well as intermittent failure history on a WRA provides the opportunity to rapidly analyze the defect patterns which can be used to increase the quality of the WRA and the availability of the aircraft.

PHASE I: The study must take into account the U.S. Navy support system and the Prime Contractor/Major Contractor production system. Selected WRA Suppliers will be contacted such that the proposed tracking system will maximize benefits to costs. The final report will quantify the long term savings to the U.S. Navy. The report will identify the optimum final state and contain a road map to get there.

PHASE II: A prototype architecture will be developed and field tested on the F/A-18 or a subset of the avionics. Existing computer hardware and software will be used where feasible; however, expenditures are expected. The prototype will focus on the highest contributors to avionic failures and high dollar WRAs. The prototype will include the Supplier of the WRA, McDonnell Douglas, and the U.S. Navy.

PHASE III: An integrated parts status and tracking computer system has proven their worth in the commercial universe with high dollar components such as computer systems. The Navy support system offers unique problems in implementation with potentially large financial and quality gains.

N93-205 TITLE: JTIDS/MIDS (Joint Tactical Information Distribution Systems/Multifunctional Information Distribution System) Cooperative Tactics

CATEGORY: Advanced Development

OBJECTIVE: The objective is to investigate how a system like MIDS can contribute to cooperative tactics such as ASW, CAS, A/A, and A/G warfare.

DESCRIPTION: JTIDS/MIDS provides the means for a fighter aircraft to transmit/receive a great deal of information to/from other fighters and Command and Control (CC) platforms. This networking greatly increases the effectiveness of the battle group. The details of how a system like JTIDS/MIDS can support A/A, A/G, ASW, CAS, cooperative jamming and cooperative passive ranging and tracking has not been fully investigated.

PHASE I: The study will research and document the form of presentation material the concept of operation for all warfare and applicable missions. The purpose of phase I is to narrow the scope of activity for phase II.

PHASE II: A warfare model will be used to quantify the performance of the concept of operations for the selected missions. An industry and government search of existing models will be performed. If one is not found, tailoring of an existing model will be part of this phase. Tactics will be hypothesized to support the concept of operations taking advantage of the JTIDS/MIDS network capabilities.

PHASE III: JTIDS/MIDS is planned to be fielded on U.S. Navy, U.S. Air Force, and NATO (including French) land, sea and air platforms. This phase will include the study of the best Navy only networks, joint U.S. forces networks, and joint NATO networks. The networks should take into account the connectivity requirements between force units. The model acquired in phase II will be used to investigate international battle group components.

N93-206 TITLE: Communication Network Saturation

CATEGORY: Advanced Development

OBJECTIVE: The objective is to determine how many aircraft to aircraft communication networks can be operating in a given geographical area.

DESCRIPTION: JTIDS/MIDS provides the means for a fighter to transmit/receive a great deal of information to/from other fighters and Command and Control (CC) platforms. However a given network can absorb a finite number of nodes before performance is degraded due to node interaction. JTIDS/MIDS is planned to be fielded on U.S. Navy, U.S. Air Force, and NATO (including French) land, sea and air platforms. It is planned that multiple JTIDS/MIDS networks will be operating within a given geographical area. These should be able to operate without interfering with each other to a great extent.

PHASE I: The study will research, model, and document the saturation point where performance becomes unsatisfactory. The study will determine the metrics of quality and unsatisfactory network performance with a given realistic topology.

PHASE II: Several U.S. Navy network topologies will be digitally modeled such that the saturation point for a given geographical area can be assessed. The product of this phase will be minimum areas for a set of U.S. Navy networks.

PHASE III: This phase should result in an algorithm or a set of rules (curves) determining the number of nodes and topology for a given geographical area. This phase will include best Navy only network, joint U.S. forces networks and joint NATO networks. The networks should take into account the connectivity requirements between force units for the type of conflict the U.S. is envisioned to get involved with.

N93-207 TITLE: Sensor Data Interface Definitions for Tactical Reconnaissance Systems

CATEGORY: Advanced Development

OBJECTIVE: Study and recommend a standard set of sensor data interfaces to be used in the implementation of Tactical Reconnaissance Sensors into a complete reconnaissance system.

DESCRIPTION: Advanced Tactical Air Reconnaissance System (ATARS) and EO LOROPS are two multi-service tactical reconnaissance development programs intended to provide a reconnaissance capability to a variety of airborne platforms including the F/A-18D. These systems interface with a ground station while in the air via a data link or after landing by removing the recorded digital data from the airborne tape recorder and supplying it directly to the ground station. The Joint Services Imagery Processing Station (JSIPS) is another multi-service development effort to provide a ground station to process and exploit reconnaissance data. The JSIPS is modular and includes a Tactical Input segment, imagery exploitation segments and provisions for a common Radar (data) processor to process airborne recorded phase history Radar data. The airborne sensor data processing and data handling capabilities of both ATARS and EO LOROPS is oriented and optimized for the specific sensors of those systems (i.e., Electro Optic) and no real design emphasis has been given to other types of reconnaissance sensors like radar.
Although basic interoperability may be possible in the design of the ATARS, EO LOROPS and the airborne Radar sensor of the F/A-18D (APG-73), there currently is no standard or interface definition of Radar sensor output, control, and/or data formats between the sensor, the airborne reconnaissance system and the ground station.

PHASE I: The study should address the requirements for current and future sensors airborne platforms and ground processing/ exploitation stations. It should research and document the capabilities which currently exist or are readily available and not dependent on the development of a new technology.

PHASE II: Contractor shall develop a prototype architecture of a future sensor data interface.

N93-208 TITLE: Reconnaissance Data Recording

CATEGORY: Advanced Development; Weapons System Environment

OBJECTIVE: Study and recommend potential areas for development of recording technology which meets the need for airborne installations in Tactical Reconnaissance aircraft.

DESCRIPTION: The current standard for recording of tactical reconnaissance sensor data is the tape recorder. This technology was chosen primarily because if offers the advantages of high storage volume and high data records rates. The current state of the art in airborne tape recorders does, however, impose limitations which makes it less than ideal for the purpose. These limitations include:

- Limited operating temperature range (due primarily to tape limitations)
- Limited operating humidity restrictions (due primarily to tape limitations)
- The requirement for pre-conditioning of tapes prior to and during operation.
- Limitations on data manipulation due to spool rates of the recorders (i.e., Fast Forward/Rewind, etc.)
- The size and volume of current airborne qualified recorders

PHASE I: Conduct study and recommend an approach to overcome the limitations of current recording systems and still provide the functionality necessary to make Tactical Reconnaissance systems effective. This study should address and suggest areas of development over a wide variety of approaches to include improvement of tape recorders and the tape medium as well as the use of other record technologies. It should suggest near term (i.e., current or proven technology) solutions as well as identify directions for development of new technologies.

PHASE II: Contractor will provide an engineering development demonstration model for current technology.

N93-209 TITLE: Identification of Alternative Compliant Refrigerants to Replace Ozone Depleting Substances (ODS) Chemicals for Air Conditioning/Refrigeration Purposes in F/A-18 Aircraft.

CATEGORY: Exploratory Development; Environmental

OBJECTIVE: To investigate and identify alternate compliant refrigerants available which can be used to replace ODS

presently used for refrigeration purposes (i.e., FREON).

DESCRIPTION: The ultimate goal of the U.S. Navy is to totally eliminate reliance on ODS chemicals, and to eliminate emissions into the atmosphere. The F/A-18 aircraft has air conditioning/ refrigeration systems which presently use a chlorofluorocarbon (CFC) fluid which is classified as ODS. The United States pledged to eliminate CFCs by 1995. It is imperative to start exploring CFC alternatives so this goal can be achieved.

PHASE I: This study must include a thorough search for candidate materials which are non-CFC/non-ODS refrigerants suitable for F/A-18 equipment. The study must include a complete description of each material, including all known properties and provide limited test data.

PHASE II: Contractor shall develop a detailed system design package and fabricate an experimental air conditioning/ refrigeration system utilizing a refrigerant identified in Phase I study.

N93-210 TITLE: Development of Improved Battery for the Miniaturized Airborne GPS Receiver (MAGR)

CATEGORY: Engineering Development Communications

OBJECTIVE: Review current research concerning battery selection for Miniaturized Airborne GPS Receiver then design and develop a battery that meets specifications, cost, reliability and maintainability, and environmental requirements.

DESCRIPTION: The MAGR is a GPS receiver procured by the GPS JPO as a non-developmental item. It is a five channel, dual frequency receiver designed for highly maneuverable aircraft. It appears that the current battery selection is alkaline cells for the MAGR standby battery application. The decision is apparently driven by cost and availability of this type battery. This type battery does not meet temperature specification. The operational environment will cause frequent replacement on the F/A-18. The MAGR is located in the F/A-18 LEX areas which requires excessive maintenance time to access for battery replacement. An alternative low cost, available and environmental battery that meets specifications is required.

PHASE I: Review the history and battery selection report for the MAGR and complete a design for a new battery that meets all specifications to include cost, availability, reliability, environmental and maintainability.

PHASE II: Contractor will provide an *Engineering Development Model* of the new battery with testing results showing compliance with specifications.

PHASE III: Pending results of the Phase II testing, this battery could be procured for the F/A-18 MAGR.

N93-211 TITLE: Development of Surface Mount Repair Tools/Operator Training

CATEGORY: Engineering Development; Training

OBJECTIVE: To develop (1) surface mount repair tools that would lower the skill level needed for operators for repair of SRA circuit cards or (2) training to upgrade operators' skills to the necessary level.

DESCRIPTION: Current tools used to remove and replace surface mounted microcircuits require a highly skilled repair person. The purpose of this project would be to either develop new tooling and repair aids or develop new training methods to train repair personnel.

PHASE I: Study tooling now available for repairing surface mount chips. Study training available.

PHASE II: Develop new tooling and training and make recommendations for best practice or procedures for repairing SRA.

PHASE III: Possible repair kit for SRA repair.

N93-212 TITLE: Electronically Erasable Programmable Read Only Memory (EEPROM) Failure Mode Analysis

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: Develop more reliable EEPROMs.

DESCRIPTION: Determine which brand and types of EEPROMs are used most commonly on F/A-18 avionics. Breadboard them in "mock-up" situations to approximate the manner and speed at which they would run in representative selected applications in the aircraft. Gather data to determine whether the EEPROMs run in this situation most often experience (1) "pin" or "column" type failures, where the EEPROM fails as if a pin were stuck high or low; (2) "row" type failures where a specific entire memory location is faulty; (3) "cell" type failures where one particular memory location, one particular bit location is stuck high or low. We are not interested in failures due to defect in manufacture so much as the "random" and "wearout" failures experienced in the middle and end of the devices' failure rate "bathtub curve". EEPROM manufacturers are reluctant to provide such information because it does not serve their interests of appearing to provide a high-reliability product.

PHASE I: Perform an analysis and report the relative percentage rates of the different failure modes. This will be used to guide SRA-level test philosophy of EEPROMs used for parameter storage. If "pin" failures are common enough in a particular application. SRA-level Test Program Set developers can justify limiting EEPROM failure detections to "pin stuck high or low" for EEPROMs being used in that type of application. If "cell" failures are common, Test Program Set developers have information to justify a more intensive test such as a March II.

PHASE II: Phase II will consist of developing a demonstration EEPROM which could be tested in a laboratory, and will be highly reliable when used on aircraft avionics.

N93-213 TITLE: Product Data Exchange Standard (PDES) Parser

This topic is CANCELLED.

N93-214 TITLE: Data Storage Unit (DSU) Data Analysis

This topic is CANCELLED.

N93-215 TITLE: AutoTEST Model Vhsic Hardware Descriptive Language (VHDL) Parser

This topic is CANCELLED.

N93-216 TITLE: Validate AutoTEST Output

This topic is CANCELLED.

N93-217 TITLE: Development of Tools for CALS Implementation

CATEGORY: Engineering Development; Computers

OBJECTIVE: To develop tools to allow MDA and vendors to implement CALS (Computer-Aided Acquisition and Logistic Support) requirements. Two possible tools includes (1) a TPI (Test Program Instruction) that is in a format that can be called up on the CASS (Consolidated Automated Support System) station and (2) a hand-held computer, containing the information ordinarily in the tech manuals, which can be used to troubleshoot problems on the aircraft.

DESCRIPTION: Tools are needed to support CALS, a DOD and industry effort to digitally transfer information throughout the life cycle of a program (acquisition, design, manufacture, support ....) The concept requires a means to transmit, receive, store and manage "automated technical information." Currently, Support Equipment and repair personnel must use paper copies of the Test Program Instruction and the tech manuals to troubleshoot problems with avionics, test equipment and aircraft. Digital transfer of this information to the CASS station or to the hand-held computer would eliminate the need for the paper copies.

PHASE I: Generate a report outlining the approach to be taken. Evaluate CASS station capabilities and interface, and data formats that can be transferred onto CASS from other systems, and focus on one or two alternatives. Compare hand-held computer capabilities and methods of transferring information to the computer from existing software/hardware

environment. Select the best method.

PHASE II: Design and produce documentation for, and demonstrate a working model of, an on-station TPI or hand-held computer.

N93-218 TITLE: F/A-18 Aircraft Canopy Reflections

CATEGORY: Engineering Development; Materials

OBJECTIVE: Develop methods, materials and processes to reduce the canopy reflections created by crewstation displays on the F/A-18 canopy.

DESCRIPTION: The current F/A-18 display suite creates reflections on the canopy during the night operations that interfere with pilot vision. As increasingly more situational awareness is required by the crew members, more and larger display surfaces will be required to accomplish these tasks thus increasing the reflection problems.

PHASE I: Evaluate and create a optical model of the F/A-18 canopy and its existing light sources. Evaluating the display light source and canopy material types and characteristics for the F/A-18 A/B/C/D/E/F. Determine the technical merit and feasibility of methods, materials and processes to reduce the canopy reflections.

PHASE II: Develop the required methods, materials and processes and apply that concept to the analytical model and to one F/A-18 aircraft or representative mockup for proof of concept. The SBIR will be responsible for the test activity but will be aided by MDA for verification of the aircraft/display integration.

PHASE III: Follow on effort will depend on the extent of the reflection reduction, i.e., will the design changes reduce the reflections to the extent that enhances the night operations?

N93-219 TITLE: Fire Control System for Rockets and Cannon

This topic is CANCELLED.

N93-220 TITLE: NDE/I Assessment of Adhesive Bond Strength

CATEGORY: Advanced Development; Composites

OBJECTIVE: Develop nondestructive inspection method to quantify the bond strength of adhesively bonded joints for both metallic and nonmetallic structures. Any resulting measurement values shall be correlated with destructive testing results and other data on adhesive bond strength.

DESCRIPTION: Current nondestructive inspection methods do not measure strength of adhesive bond joints. A nondestructive inspection method for both production and field application to measure bond strength is required to ensure structural integrity of adhesively bonded structure.

PHASE I: Should use specimens to test the principle behind the approach selected.

PHASE II: Should use the approach outlined in Phase I to develop and demonstrate techniques to measure/assess bond strength. The design, development and test of a prototype unit shall be accomplished. The prototype unit shall be a deliverable.

PHASE III: A manufactured unit could be used commercially.

N93-221 TITLE: NDE/I Assessment of Heat Damage to Advanced Composites

CATEGORY: Engineering Development; Composites

OBJECTIVE: To develop nondestructive methods and analytical procedures/techniques to determine the extent of heat damage/ degradation in advanced composites. These efforts will require correlation of composite mechanical and physical properties (original states and degraded states) with NDE/I measurements. Furthermore, an accept and reject criteria for thermal damaged composites must be established.

DESCRIPTION: There are a variety of circumstances that expose advanced composites to excessive heat. Typically the sources of heat include hot spots in heat blankets (used for composite repair), failed thermocouples over driving heat blankets, adjacent heat sinks which require more heat, engine fires, etc. The development of NDE/I methods/techniques is essential to ensuring the structural integrity of advanced composites. The contractor should address state-of-art Navy aircraft composite systems.

PHASE I: Should consist of a study outlining the methodology to address the above issues with sufficient data to demonstrate feasibility.

PHASE II: Should use the approach outlined in Phase I to develop and demonstrate techniques to measure/assess thermal degradation in graphite/epoxy composites representative of those used in Navy aircraft. The design,development and test of a prototype unit shall be accomplished. The prototype unit shall be a deliverable.

N93-222 TITLE: Integrating Computer Aided Curing of Composites with Advanced Tooling Concepts

CATEGORY: Engineering Development; Composites

OBJECTIVE: To develop/integrate computer software that could function as a tooling design aid. There have been manufacturing technology programs which have addressed computer aided processing and an advanced tooling program. It is desired to have computer hardware and software that will be capable of performing CAD/CAM functions for tooling required for composites. Ideally this program should be capable of producing tooling for composites that induces minimal to no stresses into composite parts.

DESCRIPTION: There are a variety of circumstances that induce stresses into advanced composite parts. Mismatch of coefficients of thermal expansion (CTE) between tool and composite part. The contraction of the thermosetting resin (matrix) during its exothermic reaction which occurs upon curing also causes stresses. Part lock on is another problem where the cured composite part has to be pried off the tool. These are undesirable events which cause stresses in the cured composite part. The contractor should address state-of-art Navy aircraft composites, and how an appropriate computer system (hardware and software) could relieve these undesirable stresses.

PHASE I: Should consist of a study outlining the methodology to address the above issues with sufficient data to demonstrate feasibility.

PHASE II: Should use the approach outlined in Phase 1 to acquire/develop computer hardware and software capable of performing CAD/CAM functions for graphite/epoxy composites. This system shall be capable of designing/producing tooling for composites which induces minimal stresses into the composite part. The prototype computer hardware and software shall be a deliverable.

N93-223 TITLE: Optimized Mach Number Immune Parachute Deployment Sequencer

CATEGORY: Advanced Development; Weapons System Environment

OBJECTIVE: Develop a parachute deployment sequencer that is Mach immune and which provides optimum timing of recovery parachute deployment under all ejection conditions.

DESCRIPTION: The optimized parachute deployment sequencer shall provide unique capabilities not provided by presently available equipment. These would include, as a minimum, the following: (1) Assure immediate main recovery parachute deployment in any low altitude, low airspeed ejection and in any high airspeed ejection assure immediate main recovery parachute deployment after the maximum safe airspeed for its deployment has been reached under at least the following combinations of ejection parameters: Any ambient temperature condition, any ejected weight condition within the pilot population, and any flight path dive/climb angle. (2) Prevent main recovery parachute deployment until an airspeed safe for deployment has been reached even when a drogue failure or other anomaly has occurred such that a longer time for deceleration to that safe airspeed was required. (3) Prevent main recovery parachute deployment until an airspeed safe for deployment has been reached for all supersonic ejection conditions where the total and static air pressures that are measured on the seat (behind the detached shock wave) indicate both a low airspeed and a low altitude. (4) Provide the capability of a pre-ejection input from the aircraft air data computer to the sequencer to select one of three levels of the main parachute safe deployment airspeed such that low, medium or high risk ejection conditions can be accounted for. All the above listed capabilities shall be provided without requiring any sophisticated sensor or transducer measurements other than static

pressure and total pressure. The sequencer should be microprocessor based with state-of-art components and shall be powered by a battery source having a rapid rise output with a duration of three hundred or more seconds.

PHASE I: The design of the sequencer input data, logic circuits, power supply requirements, data storage memory capacity, et cetera along with a written description of the operational sequence and sequencing capabilities shall constitute the Phase I deliverables.

PHASE II: Two prototype optimized escape system sequencers shall be assembled and demonstrated in bench tests with static pressure and total pressure input histories representing ejections under some selected extreme and unusual escape conditions which could cause other sequencers to provide either early catastrophic or unacceptable delayed main recovery parachute deployment. Upon successful bench testing, two high speed track tests with maximum and minimum ejected mass conditions using a suitable ejection seat test bed would be run.

PHASE III: A parachute deployment sequencer has strong potential for implementation in future tactical aircraft escape systems. In addition, there are high speed drone, missile, and capsule recovery applications.

N93-224 TITLE: Conformal UHF SATCOM Antenna for Tactical Aircraft

CATEGORY: Exploratory Development; Weapon System Environment

OBJECTIVE: A need has been identified for UHF Satellite Communications (SATCOM) for beyond line of sight communications and participation in Navy communications nets. Currently available UHF SATCOM antennas are unsuitable for the Navy's high performance aircraft because of form factor, weight, intrusion into the aircraft and/or protrusion into the air stream. This research will be used to develop an antenna design.

DESCRIPTION: This study will identify electrical and mechanical concept designs of conformal UHF SATCOM antennas for high performance aircraft. The performance goals in the frequency ranges of 240 Mhz to 275 Mhz for receive and 290 Mhz to 320 Mhz for transmit are as follows:

Gain	+3 dBiC	Power Handling:	150W CW
VSWR:	1.5:1 (2.0:1 Max)	Size:	12" Dia x 5"
Axial Ratio	2 Db at 0 degrees	Weight:	15 lbs.
	8 Db at 80 degrees	Installation:	Flush Mount + 3"

PHASE I: Using their own materials, the company will build "Bread board" models of the most promising design/designs. These models will be used, by the company, to measure and evaluate performance. The deliverable for Phase I will be a final report describing the preliminary designs, performance of the "bread board" models and assessment of potential technical risks.

PHASE II: Build a "Brass Board" prototype of the most promising Phase I design. The prototype and performance data will be delieverables.

PHASE III: A Navy Phase III and/or private Phase III is possible.

N93-225 TITLE: NDE/I Assessment of Heat Damage to Advanced Composites

This topic is CANCELLED.

N93-226 TITLE: Integrating Computer Aided Curing of Composites with Advanced Tooling Concepts

This topic is CANCELLED.

N93-227 TITLE: Nonsinusoidal Technology Applications to ASW Radar

CATEGORY: Exploratory Development; Weapons System Environment

OBJECTIVE: The emergence of acoustically quiet, ROW diesel-electric threats in shallow water/LIC scenarios has led to the need for nonacoustic sensor systems to complement traditional acoustic means for search/detect/localization. Current

radars cannot be used against submerged targets; new nonsinusoidal radars give promise of doing this. The objective is to investigate the feasibility and application of nonsinusoidal radar technology to U.S. Navy maritime patrol aircraft (MPA) and to Air ASW platforms.

DESCRIPTION: This SBIR Topic will investigate, analyze, implement, test and demonstrate a prototype nonsinusoidal radar for detection of underwater targets. A theory for the propagation of slowly varying electromagnetic (EM) signals through seawater will be developed and used to predict radar performance as a function of radar design parameters. A new transmitter (antenna and driver) and receiver, based on innovative radiator technology, will be designed and prototyped. The prototype will be tested and its efficiency will be determined. Analyses leading up to the design will address such issues as: optimum pulse length and frequency; target depth determination; size, weight and power requirements for air platforms. The prototype system will be demonstrated.

PHASE I: Develop a theory describing the propagation of slowly varying EM signals through seawater. Conduct investigations and tradeoff analyses to determine the feasibility and optimum design for the new nonsinusoidal radar system. Initiate and complete the radar design. Document the theory, all investigations and analyses and results, and the proposed design in a Technical Report.

PHASE II: If Phase I is successful, enhance the theory and the design to optimize for subsurface detection in shallow water scenarios. Build a prototype transmitter, receiver and radiator. Test the prototype, and compare with theoretical predictions. Analyze the test data to determine the radiator efficiency and field strength, and the signal propagation characteristics as a function of seastate. Deliverables will be a Final Technical Report, the prototype, and associated documentation.

PHASE III: If Phase II is successful, the Navy will transition nonsinusoidal ASW radar to the MPA and Air ASW communities.

N93-228 TITLE: Precious Metal Enhanced Aluminides for Turbine Components

CATEGORY: Engineering Development; Weapons System Environment

OBJECTIVE: To evaluate several precious metals for alloying with nickel aluminides to provide enhanced oxidation and sulfidation resistance to Naval turbine engine components.

DESCRIPTION: Years of service data on turbine components (blades and vanes) have demonstrated that simple nickel aluminides do not provide the necessary environmental protection to eliminate effects of sulfidation and oxidation. Simple aluminides are attractive in that they provide good protection at a very low price. The aluminide is nearly always produced by a pack cementation process and whether it conforms to Pratt and Whitney (PWA 70), General Electric (CODEP-B1), or Rolls-Royce (Pack) specifications the aluminide product has similar properties. The marine environment encountered by Naval turbine engine components often degrades the protective characteristics of the coatings thus requiring early removal of the components.
Several studies have been conducted to evaluate enhanced vs unenhanced coatings, however, other than concluding that platinum adds significantly to high temperature oxidation resistance, only limited studies have been conducted to identify other precious metals which perform equivalently to platinum (when tested equally) and yet cost less. The platinum aluminides nearly always outperform simple aluminides, however, the high cost of platinum could add $50,000 or more to the price of a turbine engine.

PHASE I: Will consist of an evaluation of precious metals (Series VIII) and the theoretical products and properties resulting from the aluminide forming reactions. If promising combinations are found and show economical justification, Phase II will occur.

PHASE II: Will produce enhanced aluminide coatings on test coupons (3 alloys chosen by Naval Engine Airfoil Centerin conjunction with contractor) for 500 hour testing at 9000C (marine atmosphere), as well as fatigue testing. Actual engine components may be produced for engine testing.
Upon successful completion of testing, the engine CFA's will be requested to formally accept the proposed enhanced aluminide as an alternate coating for applications where platinum aluminide has already been tested and accepted.

N93-229 TITLE: Centrifugal Filtration of Corrosive Process Solutions

CATEGORY:

OBJECTIVE: To develop the technology and equipment to centrifugally filter corrosive process solutions used at aircraft maintenance activities. If successful, this technology would extend process solution lives by extracting harmful particulates, sludges and residues.

DESCRIPTION: Historically, large volume process solutions are prematurely dumped due to contamination build-ups that cannot be simply filtered out. The high temperature and corrosive nature of these solutions preclude the use of standard filtration methods. The centrifugal filters are dynamic devices that spin out the contaminants from the solution. The cleaned solution is returned to the process tank and the separated hazardous waste is drawn off into disposal drums. Conservative estimates show that removal of contaminants from alkaline cleaning solutions and electroplating baths can at least double and in many cases quadruple solution life. For example, a 1600 gallon tank of a highly concentrated, chelated alkaline scale conditioner costs over $22,000 to make up and over $8,000 to dispose of it twice a year. Although the existing centrifugal filters work well on fairly neutral, benign solutions, the technology has not been demonstrated on high temperature, corrosive solutions.

PHASE I: Phase I should consist of a study outlining the approach which will be undertaken to achieve the technology required to develop the centrifugal filter designs for all high temperature corrosive process solutions identified by the preparing activity.

PHASE II: Phase II should utilize technology developed in Phase I to actually build and deliver to the government a high capacity, efficient corrosive solution centrifugal filter that is skid or wheel mounted for portability. The government will test the filter on the variety of corrosive solutions that was identified in Phase I.

PHASE III: Will be a private commercial venture.

N93-230 TITLE: Sodium Bicarbonate Blast Decreasing and Recycling

CATEGORY: Exploratory Development; Manufacturing

OBJECTIVE: To research and develop methods to utilize sodium bicarbonate blasting to degrease and decarbonize contaminated parts; then, to separate the grease, oils and particulates from the effluent; and, finally, to recover and recrystallize the sodium bicarbonate for further use.

DESCRIPTION: The use of ozone depleting chemicals for decreasing parts will be forbidden as early as 1 January 1996. The common vapor degreaser solvent, 1,1,1-trichloroethane, will be eliminated.
Abrasive blasting with sodium bicarbonate works very well as a degreaser and has been successfully demonstrated at several NADEPs. The major drawback to this process is the relatively large amount of hazardous waste generated. The contamination content of the effluent is estimated to be 2% of the total volume, however, the entire waste stream must be handled as hazardous. Disposal cost for containerized hazardous waste is currently $17.50 per gallon and is expected to double within the next year. This project will research methods in which oils, greases and particulates are removed from the spent sodium bicarbonate and water waste stream. further processing of the solution will recrystallize the sodium bicarbonate for recovery and reuse which will enable the remaining water to be discharged into the sewer system or reused in the cleaning process. Ultimately, the recrystallized sodium bicarbonate will be ground into the original 80-120 grit size, mixed with about 0.5% Cabosil and reused as new blasting media.

PHASE I: Investigate procedures to integrate the existing sodium bicarbonate blasting technology with waste stream contaminant removal, recrystallization of sodium bicarbonate, and remanufacture or reuse of the sodium bicarbonate blast media. The approach can be a completely closed loop continuous recovery or off-line batch recovery system.

PHASE II: Construct a demonstration or pilot unit that will contain the entire blasting operation and recovery/recycling system in a walk-in blast booth with a small amount of add-on equipment. A typical set-up would be a standard paint booth with a grated floor and a flowing water media trap that dumps into a sump where the effluent can be stored pending recycling procedures. The design and methods used to demonstrate this technology will be up to the bidder. The working size of the pilot booth should be at least 10' long X 10' high X 10' wide.

PHASE III: There is potential for a phase III effort.

N93-231 TITLE: Real-Time Wavelet-Based Image Compression

CATEGORY: Exploratory Development; Communications

OBJECTIVE: To develop real-time wavelet-based approaches for image compression to be utilized for narrow bandwidth image data links.

DESCRIPTION: Image compression technology employing wavelet transforms offers the potential for the high compression ratios necessary to transmit sensor imagery over narrow bandwidth channels. This technology would provide image data link capability for many ships and aircraft, including stealth aircraft, by utilizing existing radio equipment and antennas. The use of existing communication channels would reduce costs, simplify logistics, and improve interoperability. Innovative ideas are sought for the design and implementation of a system applying wavelet theory to real-time image compression. Real-time in this case means that the compression/reconstruction process operates quickly enough that no noticeable image latency is introduced as viewed by an operator on a monitor. Solutions are sought for compression of both static (single frame) images as well as video sequences (consecutive frames in time). Innovative solution, which utilize the wavelet transform domain for supplementary signal processing mechanisms as a function of position in the image or frequency subband, are welcomed. Emphasis will be placed on solutions which operate in real-time and provide for the best tradeoff of image quality versus compression ratio for digital imagery from EO, IIR, and LADAR sensors. Design should take into account sensitivity of reconstructed image quality to jamming and noise environments.

PHASE I: Provide detailed analysis of the proposed design, including feasibility of the proposed algorithms, and a plan for experimental evaluation.

PHASE II: Design software and hardware, and perform gate level simulations and timing analyses to verify the technical approach. After a successful preliminary design review, fabricate and test a hardware prototype of the wavelet image compression system, characterizing system performance in a noise/jamming environment.

PHASE III: There is potential for a Navy funded Phase III effort.

N93-232 TITLE: Government Wide/Para-Military Applications of Unmanned Air Vehicles (UAVs)

CATEGORY: Advanced Development; Weapons System Environment

OBJECTIVE: Evaluate and demonstrate that systems from DoD UAV programs can be applied to various government-wide and para-military applications of UAVs in an effective and affordable manner. The benefits of additional development options, cost reduction, reliability, supportability, and enhanced performance will then be felt in ongoing DoD UAV programs.

DESCRIPTION: A variety of air vehicles, sensors, data links, and ground control stations have completed or are completing development for DoD UAV programs. The integration of these technologies into effective and affordable UAV systems which will have more cost effectiveness and availability than manned systems to meet a significant number of potential para- and government-wide applications, e.g.: drug enforcement as related to the efforts of the Office of National Drug Control Policy, environmental/disaster monitoring; and law enforcement support, including border control and communications relay; and Corps of Engineers and National Guard surveillance and monitoring of roads; dams and rivers; pipelines; high tension power lines; fishing areas, etc.

PHASE I: Provide an analysis of the cost benefit and operational effectiveness of the use of UAVs in various government wide/para-military applications. Analyze the potential applications and provide a plan to demonstrate the utility of a UAV system meeting various applications, including, but not limited to those outlined above.

PHASE II: Demonstrate various missions determined in Phase I. Determine the support, control, cost and benefits of para-military/government wide applications. Determine policy concerning federal, state and local laws and policies regarding UAV use in government wide/para-military applications.

PHASE III: Integrate development aspects of Phase I and II to provide operational UAV support systems in conjunction with government-provided UAVs for the applications which have been proven fruitful.

N93-233 TITLE: Unmanned Aerial Vehicle Electronic Decoy Payload

CATEGORY: Machine Intelligence; Robotics

OBJECTIVE: To investigate the feasibility of an electronic decoy payload for Unmanned Aerial Vehicle (UAV) applications and demonstrate the Decoy UAV payload.

DESCRIPTION: To ensure the success of a military campaign, U.S. Forces must gain air superiority and conduct an effective air interdiction war. However, a successful air war cannot be guaranteed because of the lethality of modern air defense weapons prevalent on the battlefield. Therefore, the Suppression of Enemy Air Defense (SEAD) will be an integral part of any military campaign in the future. Using the Decoy UAV as part of the SEAD mission, the effectiveness of our military forces can be enhanced and the survivability of our air assets can be increased. The UAV electronic decoy payload will replicate electronic signatures of various aircraft. It will be capable of generating multiple false targets to draw enemy fire in order to protect our air assets. The payload will also have built-in self-protection techniques to prevent enemy radar from locking-on to the UAV. The typical decoy currently in the inventory is limited in the use of its radar augmentation device. The device can replicate the electronic signature of only one aircraft. Furthermore, its target signature does not have the fidelity to spoof a sophisticated radar, and the existing decoy cannot be recovered as in the case of the proposed Decoy UAV.

PHASE I: Propose a design of an electronic decoy UAV payload which will have a programmable waveform/signal generator and an embedded delay line. The device will be capable of coherent measurement of incoming signals; automatic waveform storage and recall; performing both amplitude and phase modulation to replicate friendly aircraft signatures; simulating target movements; and generating multiple false targets. The design will be verified by simulation.

PHASE II: A brassboard programmable waveform/signal generator/delay line will be built for demonstration.

PHASE III: A complete UAV electronic decoy payload including the receiver, power amplifier, and antennas will be fabricated for flight test.

N93-234 TITLE: Automatic Target Recognition/Cuing Using an Unmanned Aerial Vehicle Multispectral Imaging Sensor

CATEGORY: Exploratory Development; Signal Processing, Data Fusion

OBJECTIVE: To investigate the feasibility of using a multi-spectral imagery (MSI) sensor for Unmanned Aerial Vehicle (UAV) applications and demonstrate the automatic target recognition/cuing using MSI sensors.

DESCRIPTION: Different man-made or natural targets can exhibit accentuated responses to sensors operating in different spectral bands. Millimeter-wave Synthetic Aperture Radar (SAR)/radiometer and multi-band infrared sensor technology incorporated into a MSI payload can detect responses in both the millimeter-wave and infrared frequency spectrums. MSI payload data can yield a wealth of information for planners of naval and amphibious warfare operations. For ocean surveillance, MSI payload data can measure wave height, determine sea state, forecast ocean condition, identify targets, and detect ship wakes. For over-land reconnaissance, MSI payload data can be used to identify terrain features, types of vegetation, camouflage nets, concealed targets, snow and ice layer composition, and soil conditions. MSI payload data can also be used to predict beach condition, determine water depth near the shore, and locate inshore mines. Finally, MSI payload data can contribute to Automatic Target Recognition/Cuing (ATR/C) when combined with signal processing techniques. Currently, MSI data originating from reconnaissance satellites is not responsive to user needs due to the long time between satellite visits to the area of interest. A UAV MSI system would be more responsive to the operational commander's needs because it can loiter over the area of interest for extended periods of time and can provide the necessary coverage in near-realtime. MSI sensors have been employed successfully by the civilian sector in remote sensing applications, e.g., forecasting crop yield, surveying forests, mapping of potential mineral resources, patrolling ice formation for maritime safety, monitoring pollution, etc. It is envisioned that the UAV MSI system will be capable of performing similar civilian missions. These areas should also be investigated.

PHASE I: Determine the availability and suitability of various imagery exploitation and target recognition/cuing algorithms, and catalogue these algorithms for review by the UAV Joint Project Office. Perform verification of those algorithms through simulation using available imagery data.

PHASE II: Obtain suitable infrared sensor and millimeter-wave SAR/radiometer hardware and configure them into a flying testbed. Conduct flight tests and MSI measurements on targets of interest. Perform validation of those MSI algorithms deemed suitable for UAV applications.

PHASE III: Use results of the above investigations to determine the UAV MSI payload requirements and feed these inputs into a UAV MSI payload prototype effort. Fabricate a prototype UAV MSI payload.

N93-235 TITLE: EO/IR Sensor Integration for Target Identification

CATEGORY: Exploratory Development; Machine Intelligence

OBJECTIVE: Combine sensor data for EO/IR sensors for automatic target recognition. Hardware and Software, shall be high speed providing ID generally in less than 5 seconds under ideal conditions and robust.

DESCRIPTION: Next generation Navy platforms will be equipped with Electro-Optic systems such as a CCD television similar to those now deployed in the F-14, and Third Generation Thermal Imaging systems. A systems is required that will receive and combine inputs from EO and IR sensors for rapid, accurate, and reliable Non-Cooperative Target Recognition (NCTR).

PHASE I: The deliverable for Phase I will consist of the plans, drawings, and milestone for a demonstrable prototype.

PHASE II: The deliverable for Phase II will be a prototype hardware and software system that demonstrates automatic target recognition and sensor fusion for EO/IR sensors. Outputs will be compatible with currently developing Navy Hardware, such as AN/UPX-30. Cueing will be from existing Navy sensors.

PHASE III: A Navy funded Phase III effort is anticipated.

N93-236 TITLE: EO/IR Sensor Integration/Fusion for Target Identification

CATEGORY: Exploratory Development; Machine Intelligence

OBJECTIVE: Design and develop a small and cost effective systems for the automatic, rapid, accurate, and reliable identification of friendly forces to prevent fratricide and improve battle management.

DESCRIPTION: Major Naval platforms are equipped with several sensors and devices to determine the identity of unknown targets. A simple and cost effective automatic systems is needed for use by smaller platforms and individual weapons systems for the identification of friends. The systems must integrate easily with existing ID sensors and combiner/processors.

PHASE I: Phase I efforts will address the design and development of a new system for the cost effective identification of friends. The deliverable will be the drawings and figures and milestones necessary to produce a demonstrable prototype in Phase II.

PHASE II: Phase II will provide for the fabrication, test and demonstration of a new systems for the rapid automatic identification of friendly platforms.

PHASE III: A Navy funded Phase III effort is anticipated.

N93-237 TITLE: Solid State Digital Data Buffer

CATEGORY: Exploratory Development; Weapons System Environment

OBJECTIVE: In the extreme environments experienced in high performance aircraft high rate digital tape recording of images from electro-optical sensors is difficult. Airborne digital tape recording equipment has been developed which records directly on tape. The equipment is expensive and heavy. Reliability and cross play of such equipment has not been adequately proven. The objective of this effort is to develop a solid state buffer which will store imagery data for transfer at a slower rate recording on tape.

DESCRIPTION: The equipment should function with a reliability of at least 125 Hrs MTBF and operate under the following conditions without externally supplied environmental conditioning:

a. Temperatures ranges: from -30°C to +50°C
b. G-loading: -3G to +7G
c. Pressure altitude range: Sea level to 50,000 feet

Performance characteristics:

a. Data storage rate: 240Mb/sec

b. Data transfer rate to digital tape recorder: 60 Mb/second or less

c. Data storage capacity: 10 minutes of imagery data from Advanced Tactical Airborne Reconnaissance System (ATARS) or Electo-Optical Long Range Photographic System (EO-LOROPS).

d. The goal is for the equipment to store and transfer data without compression. Data compression schemes will be considered as a last resort.

Physical characteristics:

a. Weight: 35 pounds maximum

b. Size: 6"x10"x18" maximum

Anticipated usage: Internal and pod mounted installation on the Navy/Marine Corps F/A-18 aircraft for use with ATARS and EO-LOROPS.

Integration requirement: The system shall store data from the ATARS and EO-LOROPS sensors and shall be integrated with the ATARS digital tape recorder for use on the F/A-18 aircraft.

Government Furnished Equipment (GFE): Access to ATARS and EO-LOROPS will be provided during Phase I. ATARS and EO-LOROPS sensors and a digital tape recorder will be provided as GFE during Phase II.

PHASE I: Phase I is expected to consist of a study culminating in the delivery of a report which would outline the approach to be undertaken to achieve the stated requirements.

PHASE II: It is expected that the deliverable under a Phase II contract would be a breadboard system which would undergo testing with ATARS and/or EO-LOROPS on an F/A-18 aircraft. The system will be tested by Naval Aviation Warfare Center, Aircraft Division, Patuxent River, Maryland.

PHASE III: If the system proves out during Phase II, a funded Phase III EMD effort would likely ensue.

N93-238 TITLE: Digital Data Compression/Decompression Algorithms

CATEGORY: Exploratory Development; Weapons System Environment

OBJECTIVE: The storage of digital data from tactical airborne imaging sensors requires very high data rate digital tape recorders given the compression/decompression algorithms currently in use. The high data rates and the environmental extremes experienced in tactical aircraft require heavy and expensive high speed recorders and excessive environmental control requirements. The reliability and cross play capabilities of existing recorders have not yet been proven. Improved data compression/decompression schemes that provide higher compression ratios yet create no loss of resolution of the imagery after decompression will permit lower rate, lighter, less environmentally sensitive, and more reliable digital tape recorders.

DESCRIPTION: The algorithms should provide high ratio compression/decompression schemes to permit digital data from the Advanced Tactical Airborne Reconnaissance System (ATARS) and the Electro-Optical Long Range Oblique Photographic System (EO-LOROPS) to be recorded 60 Mb/second or less with no less image resolution than would be achieved without compression/decompression. The software developed must be compatible for use in ATARS or EO-LOROPS.

Government Furnished Equipment: During Phase I access to required components of ATARS and EO-LOROPS will be provided at a government facility. During Phase II required components will be provided as GFE at the contractors' facility.

PHASE I: Phase I is expected to consist of a study culminating in the delivery of a report which would outline the approach to be undertaken to achieve the stated requirements.

PHASE II: The Phase II effort would result in delivery of compression/decompression software for testing in ATARS and/or EO-LOROPS at a government facility. Testing may be limited to ground testing or may include airborne testing.

PHASE III: If the compression/decompression algorithm proves out during Phase II, a Phase III EMD effort would likely follow.

N93-239 TITLE: Computer Algorithms

CATEGORY: Advanced Development; Computers

OBJECTIVE: Develop computer algorithms for use in guidance system evaluations.

DESCRIPTION: The computer models will replicate the search, identify, lock, and track various targets in the infrared and low-light band widths for guidance sections. The model will evaluate various aspect angles with relation to background environments and tracking rates. The models will be innovative in nature and coordination with Naval Air Systems Command, AIR-5401B, is required to understand current modeling techniques.

PHASE I: Develop a model for review by Naval Air Systems Command, AIR 5401B.. Produce several tracking runs for model validation.

PHASE II: Compile, debug, and package model for delivery.

N93-240 TITLE: Sidewinder 9X Missile Domes

This topic is CANCELLED.

N93-241 TITLE: Simulation Enhancement of the FA-18 Flight Simulation with Special Emphasis on Departures and Out-of-Control Airplane Motions and Control Power.

This topic is CANCELLED.

N93-242 TITLE: NDE/I Assessment of Adhesive Bond Strength

This topic is CANCELLED.

N93-243 TITLE: Aircraft Repair and Modification Cost Estimating Query System

CATEGORY: Engineering Development; Computers

OBJECTIVE: Develop parametric cost estimating criteria and applicable values for aircraft repair and modification that will allow planners and estimators to produce project estimates by compiling various like and similar task estimates from previous projects.

DESCRIPTION: Cost estimates from previous projects will be compiled into a database with query capability by various criteria such as system, type of modification or repair, pieces of equipment to be installed, locations of the equipment, facilities available where the installation will be done, equipment that may be used for the installation, and the personnel skills available. Feedback from the actual expenditures should be used to revise the database to tailor estimates for a particular facility. This database will reduce the time needed to produce a cost estimate with a high degree of reliability.

PHASE I: Develop parametric cost estimating criteria. Design database structure for parametric data. Design algorithm to tailor and update criteria based on actual execution of previous projects.

PHASE II: Establish cost estimating values based on parametric criteria developed during phase I. Load values into database. Develop user-friendly interface menus for producing estimates. Provide report writing capability for hard copy of estimate. Interface algorithm to tailor and update parametric criteria using actual execution data and put this information into the estimating database.

PHASE III: Implement cost estimating system into current planning procedures of specific facility.

N93-244 TITLE: Novel Magnetic Detection Schemes based on Cooperative Phenomena in Nonlinear Dynamic Systems

CATEGORY: Exploratory Development.

OBJECTIVE: To develop new magnetic sensor technology by exploiting the nonlinear dynamic characteristics of magnetic sensors.

DESCRIPTION: New magnetic sensor technologies are sought, which utilize stochastic resonance and/or other cooperative effects in nonlinear dynamic systems to circumvent or take advantage of intrinsic sensor noise. Innovative techniques or devices which greatly improve existing systems are preferred as are collaborations with leading researchers in the nonlinear dynamics community. The offerors must provide clear models and explanations of the fundamental processes and quantitative descriptions of how they may be improved using techniques of cooperative stochastic phenomena in nonlinear dynamic systems. Straightforward marginal improvements of existing sensors are not sufficient. The sensors must be of practical use to the Navy and practical demonstrations are desired.

PHASE I: A detailed concept feasibility study to model the sensor performance will be carried out. The role of stochastic resonance and/or other nonlinear dynamic effects in the fundamental physical operation of the sensor should be discussed.

PHASE II: The results of PHASE I will be utilized to design and fabricate a novel (experimental) sensor that can detect weak magnetic signals (dc and non-dc) more efficiently than state-of-the-art sensors. The sensor characteristics (including all associated software) will be evaluated and compared to existing technologies.

PHASE III: The system will be installed and tested in the ADT units being developed by NAVAIR.

NAVAL AIR WARFARE CENTER/WARMINSTER

N93-245 TITLE: Forward Looking Infrared (FLIR) Image Enhancement

CATEGORY: Advanced Development; Photonics

OBJECTIVE: To demonstrate improved optical resolution by a factor of two and to evaluate the resolution-ennanced imagery for recognition of tanks and ships.

DESCRIPTION: The study will demonstrate that FLIR sensor range can be expanded in tank and ship identification. Target recognition in the infrared band is severely limited by the size of the FLIR diffraction resolution limit by 1.2 times the wavelength, divided by the entrance pupil diameter.

PHASE I: Validate predicted resolution benefits through analysis and limited simulation. The techniques will be demonstrated by using all the information available in the optical calibration data, enhancing the imagery in small patches, and solving the boundary value problem for enhancement of these small patches of imagery. This technique is called video enhancement signal processing for improved resolution (VESPIR).

PHASE II: Demonstrate benefit using actual prototype FLIR enhancement systems and digital FLIR video. All demonstrations and testings shall be documented and reported.

PHASE III: This topic has the potential for transition to PHASE III via linkage between small business and the V-22 prime contractor and/or component suppliers.

N93-246 TITLE: Antenna/Airframe Math Model

CATEGORY: Advanced Development; Simulation and Modeling

OBJECTIVE: To design a viable low profile/conformal antenna configuration that is consistent with the co-location coupling criteria for the CV-22 SOF aircraft.

DESCRIPTION: An urgent need exists for low profile/conformal antennas that will replace the projecting antennas now on the MV-22 and planned for the CV-22 aircraft.

PHASE I: The study will develop a math model with which to complete definition of criteria necessary to design the low profile/conformal antennas and to optimize their location on the aircraft.

PHASE II: Using the math model and criteria developed in PHASE I, procure/modify available antennas or design and fabricate prototypes and mount on full scale mock-up or available V-22 aircraft and perform experimental laboratory cross-coupling tests. Analyze the complete antenna coverage measurements using scale models in appropriate antenna range testing.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-247 TITLE: Low-Cost Tow Preg.

CATEGORY: Engineering Development: Composite Materials

OBJECTIVE: To improve method of fabricating epoxy resin tow preg.

DESCRIPTION: The present method of fabricating epoxy resin tow preg. suitable for use on automated fiber tow placement machines is expensive. Unidimensional three-to six-inch wide tape is produced to the required thickness. This is a standard production operation and routinely produces tape at a cost of \$60-\$70 per pound. The tape is then unreeled and slit to the required width, resulting in an additional cost of \$20-\$30 per pound (double process). A direct, single-tow process has been demonstrated to produce the required material directly from dry carbon fiber tows. Further development is required, as this process could significantly reduce machine ready tow preg. costs.

PHASE I: Evaluate slitting and single tow prepreg techniques. Optimum resins, processes, and equipment requirements will be evaluated and equipment design will be defined.

PHASE II: Scale-up process to demonstrate reproducibility. In addition, prototype equipment will be fabricated and resin selections and processes will be verified and refined.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-248 TITLE: Low-cost Prototype (Composite) Tooling

CATEGORY: Engineering Development: Composite Materials

DESCRIPTION: Current tooling technology used to produced a production run of composite components is expensive (\$300/ft^2). One alternative, plastic-faced plaster, is capable of producing a single part, but requires expensive flow-time and frequently fails during autoclave cure. Low-cost resin systems suitable for chapped fiber epoxy layup is one suggested approach.

PHASE I: Examine candidate low cost resins as tools for composite components and metal spray technology.

PHASE II: Fabricate a compound curvature graphite reinforced secondary structural composite component.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-249 TITLE: Fabrication of Thermoplastic Secondary Structures for V-22

CATEGORY: Engineering Development: Composite Materials

OBJECTIVE: Evaluation of thermoplastic composite materials and fabrication techniques for V-22 secondary structure.

DESCRIPTION: Thermoplastic composites have shown to be more damage tolerant than thermoset composite materials. Several studies have shown that doors and other secondary aircraft structure can be fabricated from thermoplastic composites at lower cost than from thermoset. This program will evaluate several V-22 structures and demonstrate that they can be manufactured for a lower cost and be more damage tolerant than the thermoset structure.

PHASE I: Perform a trade study to select highest payoff door. Evaluate fabrication methods for door and fabricate a prototype to determine processing conditions, and fabrication techniques.

PHASE II: Test prototype door fabricated PHASE I. Fabricate 5 more doors for flight test and service evaluation. Track fabrication and life cycle costs for doors as well as damage tolerance and inservice experience.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-250 TITLE: Woven Structure/Resin Transfer Molding

CATEGORY: Engineering Development: Composite Materials

OBJECTIVE: To develop methods of fabricating complex composite structures, such as the V-22 windshield/canopy frame.

DESCRIPTION: The present V-22 configuration, hot-formed and welded-titanium frame, is heavy and costly. A composite frame utilizing a dry-fiber preform, fabricated by multidimensional weaving or braiding, and resin-impregnated and cured using resin transfer molding, offers promise of reducing both weight and cost.

PHASE I: Study options and select a preform fiber architecture and resin system suitable for this purpose.

PHASE II: Fabricate a prototype RTM V-22 windshield/canopy frame and perform critical structural tests. Prototype fabrication costs will be documented and production processes defined and costs estimated.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-251 TITLE: Onboard Electrical Load Management of V-22 Aircraft Power Systems

CATEGORY: Advanced Development

OBJECTIVE: To manage the electrical power available on board the V-22 for efficient allocation during peak demand periods.

DESCRIPTION: Electrical power systems onboard fixed, rotary, and especially Tilt-Rotor aircraft have excessive demands during periods of demand heating to reduce land when operating BW systems. Methods of electrical power management need to be studied for automatically and electronically managing electrical load demands during these periods to avoid designing aircraft power systems to excessive power requirements.

PHASE I: The following studies need to be addressed in the PHASE I program:

a) A review of electrical load power budgets on a system by system by system by system basis to determine possibilities of load shedding during periods of heavy demand, such as wing heating during icing conditions and when operating electronic Warfare Systems.

b) A through review of the reliability of fault tolerant computers/sensors and electrical load circuit breaker actuators used for load shedding.

c) A conceptual design for an electrical load management system, including management system, including proposed loads and conditions for adding, dropping loads, using the V-22 electrical system in airforce variant as a model.

PHASE II: A prototype laboratory system will be developed and tested for PHASE II including components and system design proposed in PHASE I

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-252 TITLE: Innovative ECM System for Tilt Rotor/Rotary Wing Aircraft

CATEGORY: Advanced Development; Signature Control

OBJECTIVE: Identify and develop innovative concepts for defensive ECM systems for tilt rotor/rotary wing aircraft especially during VERTOL/VSTOL operations.

DESCRIPTION: Typical tilt rotor and rotary wing aircraft designs present large cross-section, slow moving, non-maneuvering targets during the takeoff, landing, and cargo/personnel insertion /extraction portions of their various mission profiles. Such performance profiles put a premium on DECM system performance for aircraft survivability. Conventional ECM solutions usually employ high power jammer and/or threat specific, complex modulation techniques which carry considerable weight and power penalties.

A study should be performed to identify innovative approaches to enhance ECM system performance. Analysis should include evaluation of emerging technologies in such areas as high speed/high power switching devices; low-weight power supplies; and self-tuning, electronically steered phase arrays. Analysis should culminate in the definition of a conceptual design to include performance estimates.

PHASE I: The following elements should be addressed during the PHASE I program.

a) Catalog threat radar characteristics to provide basis for jammer performance characteristics.

b) Determine jammer requirements based upon DECM system antenna design(s), jammer power, modulation, and aircraft

RCS Characteristics as well as engagement geometries (aspect angle, intercept ranges, exposure times, etc.).

c) Evaluate emerging technologies for compatibility with DECM system requirements defined above.

d) Develop a conceptual design based upon the selected approach and provide initial system performance estimates.

PHASE II: A prototype, laboratory system will be developed and tested to validate the technology selected.

PHASE III: The topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-253 TITLE: Metal Matrix Composite Components

CATEGORY: Advanced Development; Composite Materials

OBJECTIVE: To develop methods of manufacturing low-cost, fiber-reinforced complex structures such as transmission casings or engine compressor disks.

DESCRIPTION: A prototype gear case has been fabricated to demonstrate a direct casting process, but the technology requires further development. However, the process provides increased service life for transmissions by increasing the casing stiffness and decreasing gear and bearing wear.

PHASE I: Study available methods and/or propose a new innovative process and validate by analysis that the process can produce component shapes with acceptable properties.

PHASE II: Fabricate prototype tooling and produce prototype components with acceptable properties and reproducible quality.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-254 TITLE: Self-adaptive Notch Filter for the V-22 Flight Controls

CATEGORY: Exploratory Development

OBJECTIVE: To study the feasibility and methods of implementing a self-adaptive notch filter to mitigate unwanted structural modes in the V-22.

DESCRIPTION: On-board digital signal processing (DSP) can be used to identify structural modes by way of existing aircraft sensors. The sensors include the Standard Attitude Heading Reference Systems (SAHRS), VYROS (electronic gyros), cockpit control position sensors, accelerometers, strain gauges, and actuator position sensors. This information is available on the flight control communication busses and within the flight control computers. The DSP would be adaptive in the sense the notch filter would change frequency between pre-determined limits to center on a structural mode. Once identified, the DSP could produce a notch filter to mitigate induced structural modes using the flight controls.

PHASE I: This study will address the feasibility of implementing a self-adaptive notch filter DSP into the V-22 flight controls. A computer based generic aircraft model will be used to demonstrate a self-adaptive notch filter.

PHASE II: 1) Develop a self-adaptive notch filter for the V-22. 2) Demonstrate that the DSP can identify the structural mode while in flight and can create the necessary filter to mitigate the unwanted structural mode (does not implement filter into the flight controls under this SBIR).

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-255 TITLE: Simplified "Health of the Aircraft" Sensing System

CATEGORY: Advanced Development; Weapons System Environment

OBJECTIVE: To improve methods of detecting weakened structural elements before failure of the aircraft occurs.

DESCRIPTION: There is an urgent need for a reliable aircraft vibration and environmental structural effects detection system to be developed especially for composite aircraft. It is believed that the changes in damping and stiffness can be

detected through shifts in the normal modes of vibration of an aircraft structure. An important aspect of the study is to verify that only changes in response need to be determined; the normal modes of a structurally sound aircraft are known from preflight calibration.

PHASE I: A study using the V-22 as a demonstration model will show that by embedding a small number of lightweight sensors inside the aircraft either during manufacture or maintenance, and by employing appropriate data analysis algorithms, it may be possible to detect changes in both structural damping and stiffness during flight. The fact that the changes in damping and stiffness are caused by delamination and are the precursors of structural failure must be studied and shown to be valid assumptions.

The study should address applicability of the method to metal airframes, which are subject to corrosion failure and the delamination of adhesively bonded aluminum components. In addition, the shift in normal modes technique has potential application to detect incipient failure in power transmission gears.

PHASE II: A prototype system as defined in PHASE I will be fabricated and installed in an available V-22 aircraft and flown through appropriate flight conditions.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-256 TITLE: CBR Agent Detector for the V-22

CATEGORY: Engineering Development

OBJECTIVE: Develop an Agent Detector for the V-22

DESCRIPTION: Since Chemical-Biological-Radiological (CBR) agent contamination can go undetected both in and out of the aircraft, a detection and warning system for the V-22 is required. The system shall identify any agent contamination in the aircrew breathing system or environmental control system (ECS), and alert the crew.

PHASE I: To develop a concept for a CBR agent detector and warning system that shall identify any agent contamination in the breathing system or ECS. The detector shall identify the agent and concentration and warn the crew when unacceptable levels are reached. Detectors in the cabin and cockpit shall also be required for agent detection in these areas. Exterior detectors shall warn ground and maintenance crew if the aircraft is contaminated.

PHASE II: To fabricate an agent detector and warning system that shall integrate with the V-22 and identify any agent contamination in the breathing or ECS systems.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-257 TITLE: Agent Decontamination for the V-22

CATEGORY: Engineering Development

OBJECTIVE: Develop CB (chemical/biological) agent decontamination procedures and equipment for the V-22

DESCRIPTION: Following agent contamination, the aircraft must be decontaminated to remove the agent hazard. Procedures and equipment must be developed for safe decontamination of the V-22.

PHASE I: To develop decontamination procedures for both the interior and exterior of the V-22 that shall be effective in removing CB agent, do not damage the equipment, can be accomplished in a reasonable amount of time, and are not cost prohibitive.

PHASE II: To fabricate equipment for the decontamination of the V-22.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-258 TITLE: Laser Radar for Terrain Following/Terrain Avoidance (TF/TA)

CATEGORY: Advanced Development; Sensitive Radar

OBJECTIVE: A laser radar, with appropriate systems, has the potential for enhancing the tactical effectiveness of the V-22, MH-47E, and HH-60 aircraft by allowing the aircraft to operate at higher speeds, at lower altitudes and in more adverse weather. These features will improve the probability of mission success in SOF operations.

DESCRIPTION: The laser radar will be designed to fit the same mounts as the present microwave radar and offer better performance. The laser radars currently available use a carbon dioxide lasing medium that produces a wavelength of 10.6 microns. Although the lens system may be as large as five inches in diameter, lenses of one-inch diameter are preferred.

PHASE I: To achieve top performance, the following issues must be addressed:
Pointing accuracy and stability of the turret must be able to position the laser within 0.025 milliradian (0.0015 degrees).
The turret speed must be at least able to support a scanning efficiency of 50%. This means that it must be able to shift the beam through an accelerated move and stop cycle within 0.013 milliseconds. This high speed probably means that high sped beam shifts be accomplished optically using, for example, a moving mirror. Larger motions of the beam can be made relatively slowly with a desired rate of 90 degrees per second.
The turret must mount two laser radars that move independently. Both radars must be able to point at all positions over a 20x80 degree field-of-regard.

PHASE II: A prototype/breadboard laser radar system will be developed and tested to verify performance that meets the requirements defined above in PHASE I.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-259 TITLE: Composite Cockpit Cage

CATEGORY: Engineering Development; Composite Materials

OBJECTIVE: To provide a lighter less expensive option for the design of the V-22 cockpit cage

DESCRIPTION: The V-22 cockpit cage configuration of heavy titanium, is expensive. Titanium strength and stiffness characteristics can be replicated using composites to provide a cost and weight savings.

PHASE I: A study including a detailed analytical validation of the feasibility of using composite materials in the V-22 cockpit cage. This study must include a recommendation with design and producibility justifications for the material and processes selected.

PHASE II: A prototype structure will be fabricated on soft tooling of similar design to proposed production tooling. Critical structural testing will be completed and reported, with estimated costs per unit using proposed production processes.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-260 TITLE: High Temperature Advanced Composite Drive Shafts

CATEGORY: Advanced Development; Composite Materials

OBJECTIVE: Develop a low cost and light weight composite high temperature drive shaft.

DESCRIPTION: Filament wound composite drive shafts are used in the V-22 aircraft at several locations connecting the engines to gear boxes. The loss of the structural integrity of these shafts can result in loss of the aircraft. Current shafts are fabricated from epoxy resin systems vicinity of these components caused by combustible fluids can rapidly seconds. A shaft fabricated from advanced materials is necessary to provide protection to the drive shafts for defined loads, temperatures and durations. The resulting component shall be light weight, low cost and fit within constrained area.

PHASE I: The PHASE I program will develop concepts and preliminary component configurations.

PHASE II: PHASE II will consist of fabrication and test of one or more components.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-261 TITLE: Covert Forward Looking Sensor for V-22

CATEGORY: Advanced Development; Sensitive Radar

OBJECTIVE: To define requirements for, develop, and evaluate a covert forward looking sensor that meets, as a minimum, the performance of the AAQ-16B FLIR system.

DESCRIPTION: Currently available forward looking infrared systems are not covert. Terrain following/terrain avoidance (TF/TA) flight regimes for the V-22 would be greatly enhanced if the sensor system could be used for covert missions.

PHASE I: A study will be performed to determine:

1. Performance requirements (per AAQ-16B)
2. Data output required
3. Data output form best suited to V-22
4. Best way of displaying the forward sensor data to the pilot
5. Best way of applying the data to the V-22 flight control system
6. The candidate radar systems that provide a solution to the covert issue and will meet performance requirements
7. The best transmitted waveform to be used for each covert radar system

PHASE II: PHASE II will be a further study to determine from the PHASE I candidates which covert forward looking sensor system will be developed. PHASE II will include a computer model of the selected system to prove the viability of the concept.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contracto- and/or component suppliers.

N93-262 TITLE: Explosive Sound Source Design Aid

This topic is CANCELLED.

N93-263 TITLE: Variable Coherent Sound Source

CATEGORY: Advanced Development

OBJECTIVE: Provide a variable frequency coherent sound source which is compatible with sonobuoy form, fit and function. The results will help provide the optimum performance for the operation of sonobuoys.

DESCRIPTION: The source must be able to operate satisfactorily at depths between 100 feet and 2500 feet and provide for a variable vertical beam forming capability. It is also desirable that the source sound pressure level be variable, with a nominal 210 db re 1 uPa maximum.

PHASE I: Investigate various techniques, materials and design approaches to determine the feasibility of meeting the objective and document the study effort in a final report.

PHASE II: Develop and fabricate a prototype or prototypes of the source defined in Phase I. Conduct in house testing to validate performance and prepare a plan for conducting sea tests of the source.

PHASE III: Fabricate a test quantity of the sources developed in Phase II and conduct over-the-side type sea tests to characterize the source and validate the performance.

N93-264 TITLE: High-Temperature Self-Lubrication Ceramic Bearings

CATEGORY: Advanced Development

OBJECTIVE: To establish a production process for the manufacture of high-temperature ceramic bearings for use in future aerospace propulsion systems.

DESCRIPTION: Future naval aerospace propulsion systems will require antifriction bearing elements that will sustain high mechanical stress at temperature in the 1500 degree F range. At these temperatures, current bearing materials will soften

and not support the load. In addition, currently available lubricants will evaporate, oxidize and thermally degrade. An approach that looks extremely promising incorporates thermally stable solid lubricants as part of the bearing structure. In this fashion, replenishment of the lubricant material will be facilitated by the use of a ceramic self-lubricating retainer which will act as a reservoir for the lubricating solids. The fabrication of this retainer will be critical in achieving the desired lubrication effect in conjunction with other monolithic ceramic components such as balls, rollers, and inner and outer raceways. Hot-vacuum pressing and hot-isostatic pressing are the current methods of producing composite bearing elements. These methods should be explored as potential solutions to this problem.

PHASE I: Demonstrate bearing prototypes and develop plans for process design and specifications.

PHASE II: Develop process design and specification. Develop and build prototype system. Manufacture a quantity of bearings specified by the Navy for testing.

N93-265 TITLE: <u>Fiber-Optically Coupled Laser Beam Forming and Steering Device for Multipurpose Airborne Laser Application</u>

CATEGORY: Exploratory Development, Photonics

OBJECTIVE: Develop an electro-optomechanical device that is fiber-optically coupled to a dual laser system mounted internal to an airframe, is capable of steering laser output beams to any point within a +5 degrees, -90 degrees elevation by +/-60 degrees azimuth field-of-regard forward of the aircraft and simultaneously provides the means to receive laser return signals and spread the output beam over an adjustable range of beam divergence values from several degrees to a few milliradians.

DESCRIPTION: Current trends are to develop a separate laser system to perform a specific function: wire obstacle avoidance, velicometry, covert communications, landing zone illumination or countermeasures. This work would provide a laser beam forming and steering device that would integrate several laser-based functions within an airframe and significantly reduce the size/weight penalties imposed by the installation of separate, single function laser systems. It would also eliminate the need for a costly four-axis, servomechanically-driven gimbal platform to steer laser outputs, and provide the technology base for the potential development of a multi-purpose laser system requiring only two lasers mounted internal to the aircraft with outputs fiber-optically coupled to selected points along the airframe.

PHASE I: Identify the design of a novel laser beam forming and steering device based on fiber-optic, binary and microlens, and advanced optical technologies and component integration technologies. Perform an analytical study to define component performance and design requirements, component optical and electronic integration, and assessment of projected beam forming and steering capabilities.

PHASE II: A prototype device, based on an approved Phase I design, will be assembled and tested using low-power lasers provided as government furnished equipment and operating at select wavelengths in the 0.5 to 5 um range. Final deliverables will be a working laser beam forming and steering device and laboratory evaluation report.

PHASE III: Potential use to Navy, Air Force, or FAA

N93-266 TITLE: <u>High Speed Low-power Optical Receiver with Clock Recovery for Digital Communications</u>

CATEGORY: Exploratory Development: Photonics

OBJECTIVE: Develop a high speed compact low-power optical receiver with clock recovery circuit for use in military local area networks.

DESCRIPTION: Advance avionics architectures will feature Local Area Networks which operate at serial data rates in excess of 1 gigabit per second. Optical receivers and clock recovery circuits which operate at these speeds tend to be bulky and power-hungry, making them unsuitable for the avionics environment. The purpose of this effort is to develop a high speed, compact, low-power receiver with clock recovery suitable for operation in a military environment.
The optical receiver and clock recovery should operate at a wavelength of 1300 nanometers at speeds in the range of 1 to 2 miliwatts and supply voltages should be +/- 5 Volts. Total device dimensions should not exceed .25 x .25 x 0.1 inches. The data and recovered clock outputs of the receiver/clock recovery should be compatible with Emitter-Coupled Logic levels. Acquisition time for the clock recovery should be less than 1 microsecond and the capture range should be 100 megaHertz.

Initially the operating temperature should cover the range 0-85 Celsius with an ultimate goal of the full military temperature range. Techniques which may be considered may include but are not limited to phase-locked loops, dielectric resonators, or bulk acoustic resonators.

PHASE I: Show technical feasibility of conceptual receiver/clock recovery circuit.

PHASE II: Development of the receiver/clock recovery circuit.

N93-267 TITLE: High Density Power Amplifier for Low Frequency Active Sonobuoys

CATEGORY: Exploratory Development; Semiconductors

OBJECTIVE: Develop a high power, low frequency, high density power amplifier for use in an "A" size Active sonobuoy.

DESCRIPTION: Perform the engineering analysis, design, and development of a prototype high density power amplifier system necessary to integrate with an existing acoustic projector system for concept demonstration testing.

PHASE I: Perform an engineering analysis of the power amplifier electrical and mechanical design requirements, develop several candidate conceptual designs and recommend the most promising one for Phase II.

PHASE II: Design, fabricate, and test one or more high density power amplifiers capable of driving an acoustic projector.

PHASE III: Interface the high density power amplifier with a specified lithium thermal battery and acoustic projector. Conduct an engineering demonstration test of these subassemblies.

N93-268 TITLE: Loading System for Nondestructive Testing

CATEGORY: Exploratory Development; In-situ Evaluation

OBJECTIVE: To develop an innovative loading system that can be used in conjunction with nondestructive testing methods such as shear holography and acoustic emission, that require or could benefit from loading of parts during their use.

DESCRIPTION: The Navy has critical needs for simple nondestructive testing methods for rapidly testing aircraft components. A number of advanced techniques such as acoustic emission, thermography, and holography have the potential to test large area structures in a short period of time, provided that a uniform well characterized reproducible loads can be applied to them. Other techniques such as ultrasonic inspection, eddy current inspection and even radiography could be made much more sensitive provided the correct type of loading could be applied to open cracks during use. These testing methods could be applied to finding defects in a wide variety of aircraft components including cracks in metal bulkheads, delaminations in composite wing skins, cracks in turbine blades and disks and cracks in landing gear.
The most desirable loading technique would be portable, repeatable, quickly applicable to structures of varying shapes and sizes, would not obstruct access to the structure and would not damage it. Methods that have been tried for this purpose in the past have involved vacuum loading, thermal loading, sonic loading and impacting of the structure.

PHASE I: Develop the loading concept and perform laboratory demonstration of its feasibility.

PHASE II: Build a fieldable working model and demonstrate it with appropriate NDI techniques on real structures or components.

PHASE III: Application of device to inspection of critical aircraft components inspected by NADEP's.

N93-269 TITLE: Machinability of AF 1410 and AerMet 100 High Strength Steels

CATEGORY: Advanced Development; Flexible Manufacturing

OBJECTIVE: To determine quantitative machinability data in order to establish optimum tool life in machining of AF 1410 and AerMet 100 steels.

DESCRIPTION: Currently used ultra-high strength steels for such applications as aircraft landing gears are flaw sensitive and subject to hydrogen embrittlement and stress corrosion cracking. AF 1410 and AerMet 100 steels offer improved fracture toughness and stress corrosion cracking resistance but their machinability parameters are not well established. Use

of less than optimum machining parameters contributes to increased cost and discourages application of these otherwise beneficial high strength steels. Accurate machinability data is required to achieve optimized productivity at minimum cost in the production of naval aircraft landing gear components.

PHASE I: Should consist of a study outlining the approach and determining feasibility of quantifying the machining characteristics of AF 1410 and AerMet 100 steels by determination of tool life characteristics for each type of machining operation.

PHASE II: Entails the determination of optimum tool speed/work piece feed rates which result in minimum tool wear. Tests should include cutting force evaluations, determination of power consumption rates and characteristics of work piece surface finish. Metal cutting and rough machining operations shall be performed on the steels in the overaged (minimum hardness) condition. Finish machining operations shall be performed on the steels in the hardened and aged (maximum hardness) condition. Determination of the parameters associated with cutting, boring, drilling, grinding, milling, reaming, tapping, thread grinding and turning shall be included. Data shall be presented in handbook form.

N93-270 TITLE: Compact Tunable Optical Filter for Fiber Optic Communications

CATEGORY: Exploratory Development; Communications

OBJECTIVE: Develop a compact tunable optical filter for wavelength division demultiplexing in military local area networks.

DESCRIPTION: There is increasing interest in the use of wavelength division multiplexing to increase the bandwidth and connectivity in advanced military local area networks. This interest has resulted in a need for compact wavelength division demultiplexers which are compatible with the size and power requirements of typical fiber optic systems.
The purpose of this effort is to develop a compact tunable optical filter for wavelength division demultiplexing in fiber optic communication systems. The filter should cover the spectral range from 0.8 - 1.6 microns with 1 nanometer accuracy and resolution and 120 nonometer resolution (full width at half maximum). Transmission at the selected wavelength should be at least 50% and extinction outside the passband should be at least - 30 decibels. The insertion loss of the device should be less than -3 decibels. Tuning speed should be at least 0.1 microns per microsecond. Size and power requirements should be compatible with typical fiber optic systems used in military applications (1" x 1" x 0.125" in size, less than 20 Volts peak operating voltage). Initially the device should operate over the commercial temperature range with the ultimate goal of operation over the full military temperature range.

PHASE I: Show technical feasibility of the device.

PHASE II: Prototype development.

N93-271 TITLE: Genetic Algorithms for Flight Control Optimization

CATEGORY: Exploratory Development; Machine Intelligence/Robotics

OBJECTIVE: To develop and demonstrate the use of genetic algorithms for flight control optimization in either the design process or through on-line learning.

DESCRIPTION: Genetic algorithms have recently been demonstrated to have strong potential for improving control systems through design optimization or on-line learning. For flight control, genetic algorithms may be used to optimize either inner loop tasks such as primary command and stability augmentation or outer loop tasks such as automated trajectory control for weapons delivery or terrain following/terrain avoidance. In the case of an inner loop controller, the genetic algorithm optimization must supply acceptable pilot handling qualities. In all cases, the proposed use of genetic algorithms must be sensitive to real-world implementation issues such as validation and computational overhead.

PHASE I: The proposed genetic algorithm learning methodology should be demonstrated on a flight control system element of a simplified high performance aircraft model.

PHASE II: The genetic algorithm technique developed in Phase I will be demonstrated on a medium fidelity nonlinear aircraft model with sufficient complexity for a proof-of-concept. This aircraft model should include instabilities, disturbances, sensor noise, and uncertainties in plant dynamics.

NAVAL AIR WARFARE CENTER/TRENTON

N93-272 TITLE: Powder-Metallurgy Net-Shape Process

CATEGORY: Exploratory Development

OBJECTIVE: To investigate and develop a unique specialty metal-alloy powder process that consolidates and forms a near-net-shape preform product and to provide a single low-cost densification process which uses conventional forging presses instead of hot isostatic pressing.

DESCRIPTION: Current Navy turbine engine components produced as forgings are expensive because they require extensive machining. Much of the material is lost in machining because it cannot be disposed of due to environmental reasons. Foreign sources are now being utilized for critical strategic materials such as cobalt, chromium, tantalum, and rhenium. A potential solution to this problem is to develop a low-cost, net-shape, powder metallurgy process that can produce alloys and composites that meet the stringent requirements of today's advanced aerospace engines.

PHASE I: Develop a process using powder metallurgy with the capability to build high-performance static-vane engine components. The deliverable for this phase will be the identification of the powder metallurgy process, the process specification, and the hardware and software designs. An example process is sintering.

PHASE II: Develop and build a prototype system. Produce quantity of static vane engine components specified by the Navy for testing.

N93-273 TITLE: Lightweight, Active Noise Suppression for Small Diesel Engines

CATEGORY: Exploratory Development; Air-Breathing Propulsion

OBJECTIVE: Demonstrate the feasibility of a lightweight, active noise reduction system.

DESCRIPTION: The Navy is seeking an active noise suppression system for use on small, high speed, two and four stroke diesel engines (reciprocating and rotary) which provide propulsion power for unmanned aerial vehicles (UAVs). this system should be simple, lightweight and consume minimal electrical power from an engine driven 23 VDC alternator/generator. The system will be self contained, be mounted on the engine, and shall have minimal effects on the aerial vehicle's airframe and aerodynamics. Its weight should be comparable to the exhaust system of a 50 horsepower motorcycle engine. The active noise suppression system shall not cause any reduction of power from the engine and shall function from idle to maximum (8000 RPM) engine shaft speed. The engine shall be inaudible in all possible ambient conditions from 1000 to 12,000 feet altitude.

PHASE I: Phase I shall demonstrate system effectiveness on a reproduction of an engine noise signature with varying RPMs. It will also provide an analysis of Phase II system design which demonstrates weight, performance and packaging goals.

PHASE II: Phase II will build and demonstrate on a Navy selected UAV engine the system which meets the Phase I goals.

PHASE III: Phase III would require a team arrangement with a UAV airframer to design and incorporate the active noise suppression system into air vehicles.

N93-274 TITLE: Innovative Lightweight Hybrid Diesel/Electric Propulsion System for Unmanned Air Vehicles (UAV)

CATEGORY: Exploratory Development; Air-Breathing Propulsion

OBJECTIVE: To perform a feasibility and tradeoff study necessary to characterize a hybrid propulsion system for unmanned air vehicle airframe system.

DESCRIPTION: The Navy currently uses propulsion systems for unmanned air vehicles that are based on either reciprocating or turbine engines that deliver shaft horsepower to a propeller or rotor system. Typically this propulsion system includes a fuel tank and speed reduction gearboxes. For long duration, high altitude air vehicles it may be desirable

to replace or supplement the current configuration of components with a hybrid diesel/electric propulsion system which could incorporate solar energy, along with a diesel powered generator set, to provide flight time of weeks and months in duration. This system will have a reusable energy source and a variable speed electric drive along with a generator set to replace or supplement an engine and gearbox. Typically these systems would require peak power during approximately 20 percent of the total operating time, with the remainder of the mission (loiter) requiring 50 percent of the peak power. Nominal values for a mission length of two weeks, and 100 percent peak horsepower, should be used, though operational systems requiring 500 horsepower should be considered. Altitudes above 50,000 feet should be examined for loiter conditions. The study should provide a design concept, with all of the tradeoffs detailed, along with scaling for both greater horsepower and mission duration.

PHASE I: Phase I would generate conceptual designs which would be validated through theory and analysis, and all of the tradeoffs required to justify the concepts.

PHASE II: Phase II would consist of fabrication of subscale proof of concept designs and experimental verification of the approach.

PHASE III: Phase III would require a team arrangement with a UAV airframer to design and build demonstration air vehicles.

N93-275 TITLE: High Speed and Temperature Counter-Rotating Intershaft Seals for Aviation Turbine Engines

CATEGORY: Exploratory Development; Air Breathing Propulsion

OBJECTIVE: To design, fabricate and demonstrate an intershaft sump seal capable of full life operation at conditions required by advanced counter-rotating engines (1200 feet per second surface velocity, 1000°F air, 50 psid).

DESCRIPTION: Advanced aviation turbine engines will use counter-rotating rotors to achieve target performance levels. This design approach imposes significant challenges in the area of sump sealing, specifically in the intershaft region. Counter-rotation effectively doubles the imposed relative surface velocities for intershaft seals, which results in unacceptably low life with current design approaches. Innovative technological solutions to this challenge are sought for exploitation in a design, fabrication and demonstration type effort. Target operational conditions for the developed seal(s) include 1200 fps surface velocity, 1000°F air, and approximately 50 psid differential pressure. Seal life goal is 4000 hours.

PHASE I: Phase I would compete candidate seal concepts, refine operational requirements in the context of an advanced demonstrator engine, provide a detailed design suitable for fabrication, and provide a test and evaluation plan for the candidate seal.

PHASE II: Phase II would consist of fabrication of one or more candidate seal designs (engine quality hardware), and performance of 25 hours of operability testing and 200 hours of endurance testing at simulated mission conditions.

PHASE III: Design, fabrication, and demonstration on a full scale engine.

N93-276 TITLE: Next Generation Electrochemical Machining (ECM) Electrolytes

CATEGORY: Exploratory Development; Air Breathing Propulsion

OBJECTIVE: Apply new/advanced electrolytes in ECM technology to achieve significantly increased material removal rates, increased precision, improved surface finish, lower power consumption and improved environmental compatibility for use on advanced gas turbine propulsion materials.

DESCRIPTION: Electrochemical machining is a relatively nontraditional process based on controlled removal of material by electrolytic dissolution of the work piece. Electrolytes are normally aqueous solution of salts or may be strong hydroxides for use in select metals. Electrolytes have several proposes: a) carry the electric current between the tool and workpiece, b) heat removal and c) remove reaction products from the cutting region. Until recently, there has been a general lack of scientific understanding of the workpiece/electrolyte interface phenomena. This leads to diverse applications which are conducted under a single basic ECM process, using similar electrolytes and power process controls. Proposals are sought to investigate the use of advanced electrolytes systems (such as, but not limited to, molten salts or molten bases) as they apply to various advanced gas turbine propulsion materials. Develop analytical projections for test removal rates, precision, surface finish and anticipated improvements for advanced metal alloys, ceramics and metal matrix composites used in aircraft jet engines.

PHASE I: Phase I would identify various electrolytes and demonstrate the advantages of each electrolyte for feasibility of its removal rate on a selected advanced material, its industrial application and cost-effective use. Identify associated operation and maintenance requirements.

PHASE II: Phase II would develop, build and test a prototype ECM system capable of processing full-scale engine hardware. Demonstrate and optimize system parameters for use on selected advanced metal alloys, ceramics and metal matrix composites.

PHASE III: Navy funding to transition this technology is contingent on the quality of PHASE II results.

N93-277 TITLE: Innovative and Durable Flexible Shafts For Power Transmission In Unmanned Air Vehicle Propulsion Systems

CATEGORY: Exploratory Development; Air Breathing Propulsion

OBJECTIVE: To develop a durable flexible drive shaft for transmission of engine shaft horsepower to remote locations within an unmanned air vehicle airframe.

DESCRIPTION: The Navy is developing propulsion systems for unmanned air vehicles which may require shaft horsepower to be transmitted within an air vehicle. Typically this is done with shafts and turning gear boxes. The Navy desires to replace this technology with flexible drive shafts which should reduce weight and complexity while increasing reliability. The shaft design should consider horsepower ranges from 100 to 300 horsepower. Also the design should minimize both whirl of the shaft between supporting points and shaft wind-up. A single shaft should be capable of transmitting power through three 90 degree angles simultaneously at a radius not to exceed 12 inches, and performing for 100 hours without failure.

PHASE I: Phase I would generate conceptual designs which would be validated through theory and subscale prototype testing analysis, and

PHASE II: Phase II would consist of fabrication of subscale proof of concept designs and experimental verification of the approach.

PHASE III: Phase III would require a team arrangement with a UAV airframer to design and build demonstration air vehicles utilizing these drive shafts.

N93-278 TITLE: Performance Optimizing Full Authority Digital Electronic Control (FADEC) for High Speed Spark Assisted Diesel Engines

CATEGORY: Exploratory Development; Air Breathing Propulsion

OBJECTIVE: To develop a software and brassboard model of a real-time, optimizing control for high-speed, spark assisted diesel engines.

DESCRIPTION: The Navy is developing small lightweight intermittent combustion engines (reciprocating, rotary) for use in unmanned air vehicles. To maximize engine performance at all ambient environmental operating conditions it is desirable to utilize a digital fuel controller. These spark assisted diesels typically are designed for sea level conditions, resulting in engine performance at altitude and other ambient conditions that is less than ideal. An engine controller which responds to ambient temperature, pressure and humidity conditions to optimize performance is very desirable. Engine control parameters are typically ignition and fuel injector timing, and fuel injector duration (multiple injectors) to optimize combustion chamber performance. Optimal performance could be based on peak cylinder/rotor pressure and crankshaft speed for a commanded throttle/airspeed setting. Control input and outputs should be based on standard 0-5 vdc and/or milliamp signals. Central processing unit hardware should be constrained to current non-development items.

PHASE I: Phase I would be a feasibility study, software model and brassboard that includes timing descriptions which would be validated through theory and simulation testing.

PHASE II: Phase II would consist of fabrication of pre-production hardware/software which is suitable for use on UAV diesel engines flight engines.

PHASE III: Phase III would require a team arrangement with an engine manufacturer to build engines utilizing this FADEC.

NAVAL AIR WARFARE CENTER/INDIANAPOLIS

N93-279 TITLE: Embedded GPS Requirements (EGR) Compliant GPS

CATEGORY: Engineering Development; Sensitive Radar

OBJECTIVE: To improve overall Global Positioning System (GPS) effectiveness, increase reliability and maintainability, reduce overall life-cycle cost, and improve operational capability of the V-22 aircraft.

DESCRIPTION: A compliant GPS unit per NAVAIR standards {Embedded Global Positioning Requiremen EGR)} does not exist at this time.

PHASE I: The study will define a design and investigate the benefits of embedding a totally EGR-compliant six-channel minimum GPS unit into a possible host system in major areas.

System Total Weight - All possible host GFEs and embeddable GPS will be investigated considering an aircraft hold-down structure, the unit in weight and size, and installation cable size, and installation cable size and weight. The target weight reduction will be no less than 25 percent.

Life-Cycle Cost - A top-level cost analysis will include all associated cost and cost-drivers. The embeddable GPS receiver should require only minimal sensor input for external data sources to prepare for integration. The cost analysis will include non-recurring, recurring, and out-year funding requirements. The target cost savings will be at least 25 percent in overall program costs.

Total Volume Consumption - Investigate off-the-shelf embeddable GPS receivers and possible host systems for form and fit compatibility.

Performance - A top-level performance analysis will measure performance improvement of the embedded systems, host systems, and avionic subsystems.

PHASE II: A prototype NAVAIR EGR compliant Gps will be selected and/or developed and embedded in a host avionics unit and flown in actual aircraft to prove performance.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

NAVAL SURFACE WARFARE CENTER/DAHLGREN - WHITE OAK

N93-280 TITLE: Significance of Ultrasonic Detected Defects in Composites

CATEGORY: Exploratory Development; Composite Materials

OBJECTIVE: Develop Mathematical Analysis for Assessing the Significance of Defects in Composites Detected Ultrasonically.

DESCRIPTION: Anomalies and defects are sometimes present in glass and graphite fiber reinforced composites. These are typically detected by a variety of ultrasonic nondestructive evaluation techniques. In order to assess the mechanical significance of such detected anomalies, mathematical analysis must be performed, taking into consideration the interaction of ultrasound with assumed defect geometry and the intrinsic microstructure of the composite. Such analysis for the significance of defects are needed for cylinders, domes, shafts, and other geometrics to assist the development of ultrasonic nondestructive evaluation technology.

PHASE I: Proposer must show the foundation of analysis that can be realistically implemented in immersion ultrasonic testing environment, and discuss the implication of such detected defects when the composite article is under various mechanical and thermal loading environment.

PHASE II: Full scale analysis and software development. Fabrication of defect standards. Implementation of analysis in a commercially available ultrasonic testing system. Delivery of software and ultrasonic testing system to the Navy.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

NAVAL AIR WARFARE CENTER/PATUXENT RIVER

N93-281 TITLE: Ice Impact Protection for Thin Skin Composite Laminates

CATEGORY: Exploratory Development; Composite Materials

OBJECTIVE: To improve the resistance of thin skin composite laminates to impact from ice shards shed from proprotor blades.

DESCRIPTION: The current V-22 design will be exposed to severe icing conditions that will likely result in ice shard being shed and propelled at high velocity (300 to 500 knots) from the rotor blades, obliquely striking localized portions of the thin fuselage side wall skins. The impact resistance of the current post-buckled FSD skin design has been judged insufficient to ensure structural integrity and limit damage. The current V-22 design is extremely weight-critical and cannot tolerate a significant thickening of the skin to provide the needed impact resistance. Therefore, a development program is required to define, analyze, design, fabricate and evaluate a weight and cost efficient structural concept which incorporates commercially available energy absorbing, environmentally resistant materials to vastly improve the impact resistance of the sidewall skins.

PHASE I: Define, analyze and design several efficient structural concepts, selecting at least two for fabrication of representative lightweight fuselage skin laminates for use in coupon compression testing after impact with ice shards.

PHASE II: Design, analyze, fabricate and structurally test several V-22 representative integrally stiffened sidewall skin compression and shear panels.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-282 TITLE: Sensors for Icing Avoidance, Detection and Accretion Measurement

CATEGORY: Advanced Development; Sensitive Radar

OBJECTIVE: To design a sensor system that will detect the onset of icing conditions and to provide a quantitative estimate of the rate and degree of icing in tilt-rotor aircraft. The selected approach should accommodate the unique flight surface configurations of present-day aircraft and thus minimize the impact on the structural and aerodynamic features of the airframe design.

DESCRIPTION: A study for reliability detecting the aeration of ice on fixed wing, rotary wing, and tilt-rotor aircraft without protrusive elements on the aircraft surfaces does not exist. A system is urgently needed that is not damaged by cleaning or painting processes and for which the sensors do not penetrate or protrude above the wing and flight control surfaces.

PHASE I: To fully exploit the adverse weather potential of the current and future tilt-rotor aircraft, the means of in-flight prediction of the onset, initiation, and degree of ice accretion is desired. Since the tilt-rotor aircraft concept utilizes both rotary-and fixed-wing aircraft flight modes, the icing sensor system should effectively monitor both modes of operation. Preference would be given to approaches that minimize the impact on the mechanical and electrical integration with flight surfaces, rotor drive, tilt mechanisms and the pressure vessel.
PHASE I should use the MV-22 Osprey aircraft as the aircraft model for the conceptualization of the sensor system. It is expected that this phase would include the following activities.

- A survey of existing and new technologies applicable to the study.
- Selection of the most promising technology or combination of technologies as the basis for the study.
- A conceptual design based upon the selected approach.
- Prediction of performance of the conceptual design and development.
- A proposal follow-on program during PHASE II which would validate the technology selected and reduce the risk of a development and demonstration of an experimental prototype sensor system.

PHASE II. PHASE II will involve the design development of the technology recommended in the PHASE I study, fabrication of a prototype system, installation of an available aircraft and demonstration/testing in an environmental lab.

PHASE III: This topic has the potential for transition to PHASE III via linkage between the small business and the V-22 prime contractor and/or component suppliers.

N93-283 TITLE: Flight Test Instrumentation to Measure Rotor System Motion and Loads in Navy Helicopters

CATEGORY: Advanced Development; Composite Materials

OBJECTIVE: Develop flight test instrumentation to be used by government test activities to measure the individual main rotor blade motion and blade loads for rotorcraft.

DESCRIPTION: Helicopter flight trainers are starting to incorporate blade element rotor models to achieve a higher level of flight fidelity. This new generation of operational flight trainers (OFT) and weapon systems trainers (WST) will require helicopter blade motion and load data for validation testing. H-60 helicopter blade motion sensor instrumentation is not available at government test facilities like NAWCAD Pax River. A recent HH-60J program was forced to change the proposed blade element rotor model simulator to a rotor map model when it was discovered that instrumentation was not available to measure blade motion in the flight test data program. Blade motion instrumentation are required to independently measure rotor flapping, feathering, and lagging motions. The minimum instrumentation to get rotor blade loads for simulator model validation should also be determined.

PHASE I: Review all previous rotor blade instrumentation installations. Design blade motion sensors that could be used to measure individual axis rotor blade motion during a typical flight test program for a specified aircraft. Propose the minimum instrumentation to get rotor blade loads for blade element simulator model validation. Perform a failure and reliability analysis for the proposed instrumentation.

PHASE II: Develop the instrumentation systems. Support instrumentation installation and calibration on a specified rotorcraft at NAWCAD. Support a flight test program at NAWCAD.

PHASE III: A successful Phase II effort will result in an improved test capability and should generate interest for follow-on Phase III work.

N93-284 TITLE: Real Time Simulation Aerodynamic Updates for Flight Test Support

CATEGORY: Exploratory Development; Simulation and Modeling

OBJECTIVE: To decrease the time it takes to complete a flight test program by improving the use of simulation in the flight phases of the aircraft acquisition process through development of an expert system for real time aerodynamic analysis of flight test data.

DESCRIPTION: Simulation has become a critical technology in the development of aircraft as the basis for design decisions and for use in envelope expansion. The use of aerodynamic simulation to support this process is hampered by the amount of time it takes to keep a simulation current during the flight test development of an aircraft. Analysis of flight test data to estimate linear and nonlinear aerodynamic characteristics to update simulation data is a well established technology; however, accomplishment of this analysis for large quantities of data currently takes from weeks to months to complete. Real time estimation of linear and nonlinear aerodynamics from flight test data and subsequent updating of simulation parameters would have a significant effect on the productivity, cost and time it takes to complete a flight test program. This will be accomplished by improving simulation fidelity though the utilization of multiple system identification technologies integrated together within an expert system for aerodynamic analysis of flight data.

PHASE I: This phase will consist of a conceptual study into the application of expert system technology for automating the aerodynamic system identification process. Next a specification will be written for development of an expert system that utilizes advanced system identification techniques for linear and nonlinear estimation of aircraft aerodynamics and other simulation modeling parameters.

PHASE II: This phase will develop a computer work station using expert system technology capable of real time analysis of aircraft aerodynamics characteristics from flight test data. This work station will provide the capability of automatically integrating estimation results into the simulation data used for real time simulations in piloted simulation facilities.

PHASE III: This technology will transition to support Navy funded programs for the development of the AX, F-18 E/F and V-22 aircraft.

N93-285 TITLE: Ship Based Helicopter Position/Motion Resolving Instrumentation System

CATEGORY: Engineering Development; Weapon System Environment

OBJECTIVE: Develop a ship based instrumentation system to resolve an approaching helicopter's position, rates, and accelerations with respect to an earth fixed and ship fixed coordinate system.

DESCRIPTION: The portable system will be used in conjunction with the ship-helo combination being tested. It should be compatible with ship power, ship electromagnetic environment, and atmospheric environment. The operating system should not adversely affect the aircraft, aircrew, ship or ship's crew. It should also be light weight and man transportable for remote site aircraft/ship testing. The system should be able to determine the helicopter's approach path to the flight deck, its touch down point with respect to a predetermined reference point, and the departure path. The system should be able to accommodate a variety of flight decks, from frigate to LHA class ships. The parameters describing the above should include but are not limited to accelerations, rates, positions, and attitude. A video record of the landing should be recorded concurrently. Recorded views should include the approach stabilized w.r.t. horizon, and the touchdown w.r.t. flight deck. A time synchronization of the data replay and the video should be possible. The test department has a ship motion instrumentation package that stores data in an IEEE format. Helicopter/ship tests last 1-2 weeks, with approximately 6 hours of flight testing per day. Large amounts of data storage capability is required. The instrumentation software should be user friendly menu-driven, and IBM PC based. The option of real time data review should be available.

PHASE I: Develop a preliminary instrumentation system design. Also identify required sensors to support the aircraft motion sensing.

PHASE II: Complete the instrumentation system design. Build the instrumentations system, in accordance with applicable MIL STDS, and acquire aircraft motion sensor system. Demonstrate system operations and check-out at the Naval Air Warfare Center Aircraft Division (NAWC AD). Also demonstrate system operation and check-out during an NAWC AD helicopter/ship at-sea Dynamic Interface (DI) test. Evaluate compliance with stated objectives. Provide complete documentation and user instructions for the ship instrumentation system and associated sensors.

PHASE III: A funded Phase III effort is anticipated to apply the program results to commercial helicopter/ship operations.

N93-286 TITLE: Flight Test Instrumentation to Measure Rotor System Motion and Loads in Navy Helicopters

CATEGORY: Advanced Development; Composite Materials

OBJECTIVE: Develop flight test instrumentation to be used by government test activities to measure the individual main rotor blade motion and blade loads for rotorcraft.

DESCRIPTION: Helicopter flight model when it was discovered that instrumentation was not available to measure blade motion in the flight test data program. Blade motion instrumentation are required to independently measure rotor flapping, feathering, and lagging motions. The minimum instrumentation to get rotor blade loads for simulator model validation should also be determined.

PHASE I: Review all previous rotor blade instrumentation installations. Design blade motion sensors that could be used to measure individual axis rotor blade motion during a typical flight test program for a specified aircraft. Propose the minimum instrumentation to get rotor blade loads for blade element simulator model validation. Perform a failure and reliability analysis for the proposed instrumentation.

PHASE II: Develop the instrumentation systems. Support instrumentation installation and calibration on a specified rotorcraft at NAWCAD. Support a flight test program at NAWCAD.

PHASE III: A successful Phase II effort will result in an improved test capability and should generate interest for follow-on Phase III work from the major helicopter manufacturers/testers.

N93-287 TITLE: Variable Twist Rotor Blade to Optimize Tilt Rotor Aircraft Performance

CATEGORY: Exploratory Development; Simulation and Modeling

OBJECTIVE: Design, analyze, and simulate a variable twist rotor blade system that could be used to help optimize the

performance of a tilt rotor aircraft like the V-22.

DESCRIPTION: Tilt rotor aircraft, like the V-22, are required to operate in flight conditions ranging from hover and low speed to high speed cruise. It is not possible optimize the performance of a tilt rotor aircraft by using rotor blades with a set amount of twist. The ideal amount of blade twist will vary from hover to forward flight. Without variable twist rotor blades it will not be possible to optimize the performance of a tilt rotor aircraft like the V-22 for both hover and forward flight.

PHASE I: Design a variable twist rotor system that could be used to help optimize the performance of a tilt rotor aircraft like the V-22. The blade twist should be controllable in flight as a function of flight condition. Conduct a preliminary analysis of the variable twist rotor system.

PHASE II: Conduct/support non-real time and real time simulations comparing the variable twist rotor system to the current V-22 rotor system. Also, evaluate the rotor system aerodynamic, stability, controllability, and elastic characteristics. The simulator and simulation model structure to be used in this program will be specified by the Navy.

PHASE III: If Phase I and Phase II are successful, the Phase III effort would involve developing scale models for wind tunnel testing and conducting whirl stand testing of prototype blades. Interest from potential commercial tilt rotor manufacturers would be high since optimum tilt rotor performance is required for commercial applications.

NAVAL RESEARCH LABORATORY

N93-288 TITLE: Rapid Prototyping and Simulation with Programmable Gate Arrays

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the feasibility of rapidly determining whether or not a processor design is suitable, from a performance perspective, for its intended application. Related to this is the demonstration of the feasibility of rapidly constructing an operational piece of hardware that implements the functionality of the processor of interest, that performs adequately from a real time perspective, and that can be electrically connected to other hardware elements with which the processor is operationally integrated. In short, it is the problem of rapidly constructing a physically realized hardware prototype.

DESCRIPTION: Programmable gate arrays are a component technology that is potentially very useful in solving rapid prototyping problems. The technology provides a programmable hardware element that could be made to represent essentially any arbitrarily complex digital circuit. The individual gate array circuits are VLSI devices and contain several thousand gates each, organized into hundreds of configurable logic blocks. It is a very flexible, potentially useful technology. Recent activities towards the exploitation of this technology have focused on the problem of providing 'arrays of programmable gate arrays'; that is, the focus is on the problem of interconnecting the gate arrays in networks, so that one could map very large digital circuits onto the network. This will eliminate the fairly severe limitations on the utility of the technology, when applied one device at a time, and open the doors to the possibility of processor rapid prototyping. The proposed solution to the processor rapid prototyping problem brings together two technologies in an eminently synergistic manner. The first is the Programmable Gate Array (PGA) circuit technology; the second is the JRS Integrated Design Automation System (IDAS) technology. PGA technology is being pursued by constructing large arrays of the devices, that will provide between 500,000 and 1,000,000 equivalent gates or 10,000 to 20,000 configurable logic blocks, that can be automatically configured to represent complex processors. This size array can be packaged onto one VME size board that plugs directly into the backplane of an appropriate host (e.g., SUN). The PGA board can then be driven by the host processor; it can be configured by it; it can receive static or dynamic input data from it; and, it can return output data to it, statically or dynamically. The host processor provides the environment for testing a prototype, for doing an evaluation of its suitability or comparative effectiveness. The PGA board becomes a hardware simulator/emulator of the target processor; it provides the test bed for testing and evaluating alternatives. The PGA board can then be the actual physical hardware prototype or the configuration data can be transferred to other physical instantiations that might be more useful in a particular system environment. IDAS technology provides the processor synthesis tools and the links to designers working in VHDL that are necessary to effectively utilize the potential of the PGA board in a significant manner. Processor synthesis in IDAS creates processor representations that are implemented in components contained in libraries and are expressible in VHDL. The VHDL description is then processed to generate a software simulator for the implemented processor. One will then be able to use IDAS to synthesize application specific processors, simulate and evaluate them very fast on the PGA Board, and return results to designers. The configured PGA Board, or a translated

image of it, could also be used as a physical prototype for actual interconnection to other hardware such as the backplane of the AN/UYS-2.

PHASE I: Construct 500,000 to 1,000,000 equivalent gates array packaged onto one VME size board that plugs directly into the backplane of an appropriate host (e.g., SUN). Configure and produce software on the host processor to provides the environment for testing a prototype, for doing an evaluation of its suitability or comparative effectiveness.

PHASE II: Utilize the IDAS technology to provide the processor synthesis tools and the links to designers working in VHDL that are necessary to effectively utilize the potential of the PGA board in a significant manner.

PHASE III: Produce commercial production grade tools, distribute and support.

N93-289 TITLE: Airborne Sensor Front End Signal Processing Unit

CATEGORY: Exploratory Development

OBJECTIVE: To develop a compact, real-time electronic device capable of performing non-uniformity correction for 256x256 staring focal plane array sensors. Additionally, optimized bit compression to 8 bit format is desired but not required.

DESCRIPTION: High efficiency staring focal plane array sensors are becoming available in large numbers and low costs as to be desirable for airborne Navy applications such as surveillance, precision strike, and missile warning. Such sensors have reduced capability due to spatial non-uniformities. Spatial, temporal, and neural methods may be used to reduce such non-uniformities close to the temporal noise level without constant recalibration. Real-time correction of such sensors in compact hardware would be desired for both Navy, DoD, and commercial applications. Additionally, intelligent (optimized as opposed to truncated) compression of 12 bit focal plane array video imagery into 8 bit video format is desirable from a standpoint of practicality.

PHASE I: Is to design and characterize a real time non-uniformity corrector capable of operating on a 256x256 focal plane array operating at 30 Hz. The electronics should be packaged according to commercial standards with the ability to function in flight, weigh less than 15 pounds and have less than 1 liter volume. The corrector shall be such that further reduction of volume to under 100 cm**2 does not require drastic reconfiguration.

PHASE II: Is to construct such a device and test it using a MWIR or LWIR high quantum efficiency focal plane array. Performance of the correction technique shall be characterized. Optimal video bit compression is desired but not a requirement.

N93-290 TITLE: Airborne Multispectral Sensor Arrays

CATEGORY: Exploratory Development

OBJECTIVE: To develop a practical airborne staring focal plane array sensor for Navy applications in surveillance, precision strike, and/or missile warning. Such a sensor should have closely aligned frames in two or more selected spectral bands.

DESCRIPTION: Staring focal plane array sensors with high quantum efficiency are becoming available in large numbers. Applications such as missile warning, precision strike, and overhead surveillance are enhanced by use of closely aligned multispectral imagery for clutter reduction and enhancement of desired features / contrast. Techniques to implement practical, effective, and inexpensive airborne multi-color sensors are needed. The contractor is expected to have one or two key personnel with security clearances for discussion of desired spectral bands within MWIR and/or LWIR spectral bands. Spectral bandwidths of .1 to .5 microns wide are desired for various applications.

PHASE I: Is to design a focal plane array sensor capable of multi-spectral operation. At least one spectral band should be in the 3.8 - 4.8 micron band with at least one other spectral band either in MWIR or LWIR. Attention should be paid to practicality for mass production and airborne integration.

PHASE II: Is to develop and demonstrate a focal planearray sensor camera with at least 256 x 256 pixels, capable of being fitted with 2 lenses: one in the 6 - 30 degree field of view and the other 60 - 90 degree field of view. The sensor need not be compact or ruggedized for airborne use; however, it should be transportable for ground/sea/hilltop data gathering AND its design should not be such that the technology could be later adapted for aircraft use.

N93-291 TITLE: Passive Tracking for Countermeasure Effectiveness

CATEGORY: Exploratory Development

OBJECTIVE: To develop, code, and validate algorithms for a passive fine tracker capable of rapidly determining when a guided missile has been effectively been rendered non-threatening by soft-kill (e.g. RF/EO/IR/MMW electronic warfare countermeasures) means.

DESCRIPTION: Navy aircraft are vulnerable to smart (guided) missiles. While Electronic Warfare (EW) countermeasures exist and are being further developed for Navy aircraft, these counter-measures, even when successful do not produce prompt missile hard kill. The pilot's lack of knowledge of the effectiveness of the EW suite could lead to dwelling on an already negated target, using ineffective technique, or prematurely ceasing employment of a countermeasure technique prior to its being effective. With prompt, reliable countermeasure effectiveness, one might reduce the number of expendibles used, optimize jamming/spoofing strategies, and decrease the single-shot susceptibility of the Navy aircraft. The SBIR effort will focus on use of sub-milliradian accuracy passive fine tracking with an optional parametric excursion into use of an active ranger for 3-dimensional trajectory tracking. Detailed missile flyout codes such as DISAMS and ESAMS are available as GFE.
Contractor security clearance and computational facilities to the SECRET/NOFORN/WNINTEL level are required.

PHASE I: Is to develop and test algorithms for passive countermeasure effectiveness. At least 1 surface-to-air and one air-to-air missile type must be studied.

PHASE II: Is to code in real-time software, a precision pointer-tracker (GFE hardware or equivalent imagery simulation may be used). Tracker noise, latency, and jitter issues must be addressed. Software will be tested on data or engagement simulations for at least 6 different anti-air missile types. The tracker must be sensitive to track burning and post-burnout missiles with sufficient signal/noise for as required.

PHASE III: Possible follow-on to Airborne IRCM ATD's or applicability to shipboard SLQ-32/54 MATES follow-on

NAVAL AIR WARFARE CENTER/CHINA LAKE

N93-292 TITLE: Pulsed Detonation Engine

CATEGORY: Exploratory Research; Air-Breathing Propulsion

OBJECTIVE: To establish a basis for the Pulsed Detonation Engine (PDE) and prepare a proposal that would detail the applicability of PDE technology to Navy Missile Systems that are either existing, are under current development, or under consideration.

DESCRIPTION: With the recent reduction in defense funding, a need arises for a propulsion concept that is less expensive but offers higher performance than propulsion systems currently in use. The Pulse Detonation Engine embodies such a concept. PDEs employ an air breathing, constant volume process, marked by high gas pressures (10-100 atmospheres) and temperatures (>2000°C). These are conditions with higher power densities than conventional engines.
Like all air breathing engines, PDEs offer a higher specific impulse than solid rocket motors. But unlike turbojets, PDEs do not require mechanical devices to compress the air prior to combustion; and unlike ramjets, they do not need to convert inlet air velocity into pressure. Since no pre-compression of gasses is required, the engine is very light and mechanically simple. Recent analysis has indicated that a single PDE configuration can operate at a broad range of Mach numbers, $0.2 < M < 3.0$, in a fuel efficient manner. Feasibility studies done in the 50's and 60's involving tests of a single linear tube operating under intermittent combustion resulted in specific impulses above 2100 sec; recent simulations had specific impulses in excess of 4000 sec. Recent experiments at the Naval Postgraduate School have 1) established the feasibility of intermittent fuel injection at a chosen frequency, 2) shown the effectiveness of self aspiration and 3) shown the demonstrability of a primary detonation as a driver for the main detonation.

PHASE I: Compile a feasibility study to determine a missile-applicable PDE configuration. Determine which missile/mission profile would most benefit. Conduct performance trade-offs between PDEs and conventional engines as applied to Navy missiles. Synthesize preliminary designs of both heavyweight and flightweight hardware, preferably modular for ease of retrofit. All relevant issues must be addressed: structures, harmonic coupling, especially sensitivity.

PHASE II: Fabricate heavyweight hardware and conduct testing, proving the operability of the ideal PDE

configuration.

N93-293 TITLE: M197, 20mm Sabot Deflector Retrofit Kit

This topic is CANCELLED.

N93-294 TITLE: Electrochemical Milling/Finishing of Rifling in Gun Barrels

CATEGORY: Engineering Development; Flexible Manufacturing

OBJECTIVE: To develop techniques to accurately and efficiently electrochemically mill the interior surface and rifling in medium caliber (20mm to 30mm) automatic cannon barrels.

DESCRIPTION: A need exists to improve the finishing and rifling of medium caliber gun barrel bores. Techniques that would provide a more accurate bore and rifling while increasing the process speed is desired. Further a process is required that does not induce residual stresses or effect the heat treat condition of the barrels during this finishing process. The resulting finish should be such that the barrels are amenable to hard coat plating after the smoothing-rifling process.

PHASE I: This task would involve using electrochemical milling techniques to (1) finish the bores of two 25mm automatic cannon barrels and (2) cut rifling grooves in these two barrels. The production capabilities of these techniques would be demonstrated.

The finished bore shall have an internal diameter of 25.05 ± 0.03mm throughout the length of the rifled section and shall have a surface finish of 20 rms or better. The depth of the rifling grooves shall be 0.53 ± 0.02mm with the sides and bottom of the groove also having a 20 rms surface finish. There shall be 19 grooves equally spaced around the internal diameter of the barrel. The lands and grooves shall be equal in width. The corners of the lands shall be sharp with no more than a 0.05mm radius and the groove bottom radius shall not exceed 0.20mm. The rifled length of the barrel shall be at least 70 inches. The process must be capable of producing either a constant twist or a progressive gain twist rifling schedule. Production rates on the order of 15 inches of barrel rifling or finishing per minute are required for constant twist rifling.

PHASE II: This effort would thoroughly test the Phase I deliverable items consisting of the two finished gun barrels for tests, a data package on the equipment used for finishing the barrels and a process description.

PHASE III: None currently planned.

N93-295 TITLE: Develop an Improved Thrust Vector Control Jet Vane

CATEGORY: Exploratory Research; Air-Breathing Propulsion

OBJECTIVE: The objective of this work is to develop an improved thrust vector control jet vane for missile control system applications. Innovative methods are sought to improve on the state of the art with respect to jet vane airfoil performance, durability, weight, and cost. Innovations can include new materials and/or new design approaches that address problems outlined below.

DESCRIPTION: Thrust vector control vanes are generally thick short span double wedge airfoils using a large mass of material to provide heat capacity. Currently, transpiration cooling is used to enable a vane to handle the high heat transfer environment of a rocket plume. A refractory metal matrix infiltrated with a sacrificial coolant metal (e.g. Copper-Infiltrated Tungsten) provides structural strength and abrasion resistance. Basic improvements are needed to reduce weight, improve abrasion resistance, yet meet severe thermal conditions that are a significant part of the problem. The stagnation point temperature can exceed 6000 F. For undeflected vanes in 18% Aluminum propellant stagnation point heat transfer is on the order of 5.5 btu/sec/ft^2/F. Sidewall heat transfer may exceed 0.6 btu/sec/ft^2/F. Thus the thermal conductivity of the material should exceed that of copper. Additionally, the vane surface material should have a hardness capable of withstanding the abrasion caused by hot alumina in the rocket plume exhaust.

PHASE I: Under the Phase I feasibility study a tradeoff of concepts should be developed leading to a proposed design for Phase II. The degree of success in meeting or exceeding benchmark design goals will be used to judge performance potential from the proposed Phase I design. Benchmarks include an airfoil thickness to chord ratio of less than 15%, a vane density of less than 0.6 lb/in^3, predicted vane erosion of less than 25% mass for a 4 second exposure to an

18% Aluminized HTPB propellant plume. A suitable mechanical interface will allow attachment and actuation. It must be feasible to actuate the vane through or around a nozzle wall and provide protection of actuation hardware from (25 psi) exhaust gases.

PHASE II: The ability to show that a device can withstand the thermal conditions will be an important part of the Phase II effort. A prototype will be designed and tested under this portion of the effort.

NCCOSC/NRAD/SAN DIEGO

N93-296 TITLE: Microcircuit Device Package Marking and Recognition

CATEGORY: Advanced Development

OBJECTIVE: Assess current defects, define requirements and do a technology assessment of microelectronic product marking or labeling methods. Provide a preliminary design of a marking and recognition system using a suitable method such as bar code, labeling, or character marking that shows a possibility of meeting requirements. Although this work will benefit the electronics packaging industry as a whole, only the requirements for hybrid microelectronics manufacturers should be addressed.

DESCRIPTION: The manufacturers who presently develop electronic packaging for the military require improved package marking or labeling techniques during their manufacturing process. The package markings must withstand stringent requirement as detailed in Mil-Std 883D. (A copy of Mil-Std 883D may be obtained from the Naval Supply Systems Command contact listed in the front of this Navy section).

The markings facilitate product tracking during the manufacturing process but also provide a means of meeting the traceability requirements for manufacturing military electronic packages that are associated with various weapon, electronic warfare, command and control, surveillance, and intelligence systems. The most widely used marking process is accomplished by painting over part of the gold surface electronic package, to eliminate reflectivity or contrast problems, then laser etching to the painted surface. During the manufacturing process, the electronic package is exposed to cleaning solvents that can destroy the painted surface making the markings unreadable with traditional bar code technology or character recognition techniques. Other marking processes result in adherence problems and corrosion from excessive marking depth.

PHASE I: System analysis support in the definition and assessment of marking requirements used by the hybrid microelectronics industry will be provided. This includes the applicable sections of the appropriate standards; Mil-H-38534, Mil-Std-883D, Mil-Std-1189. The contractor shall evaluate and determine estimates of costs associated with the various marking and labeling methods and technologies. Costs and feasibility of correcting deficiencies in existing methods and technologies should also be made. Actual or estimated list prices of current off-the-shelf marking, labeling, and recognition equipment are also desirable. Various technologies which should be investigated include but are not limited to laser marking, laser scribing, engraving, labeling, direct circuit writing.

PHASE II: A preliminary system architectural design of a system that meets military requirements shall be accomplished. This systems engineering effort will include hardware and software analysis, trade-off and optimization studies, and development of preliminary system specifications. The design must specifically address the requirements identified in Phase 1.

PHASE III: A marketable product that meets government and industry needs.

NAVAL AIR WARFARE CENTER/POINT MUGU

N93-297 TITLE: Integrated IR/RF Scene Generation for Closed-Loop Missile Engagement Simulators

CATEGORY: Engineering Development; Simulation

OBJECTIVE: Incorporate IR scene simulation capability into an existing, closed-loop RF missile engagement simulation laboratory.

DESCRIPTION: The requirement to develop, test and evaluate multispectral (IR/RF) seekers has stimulated much recent activity in IR scene generation technology. Scene combination, the overlay of a registered IR scene (image) on an RF

simulation has proven to be one of the most challenging requirements and is the subject of a current innovative research effort. This research will culminate in development of a dichroic (beamsplitter) screen for hardware-in-the-loop laboratories which is reflective in the infrared (IR) region and transmissive in the microwave region. It is desired that this beam combiner be incorporated into an existing, closed-loop RF missile engagement simulation laboratory.

PHASE I: Develop a preliminary design for incorporation of the dichroic screen into an RF test facility. Critical questions and issues to be resolved include: Number of degrees of freedom required, Image distortion as scene incidence angle is varied, Pattern cell size, System integrity under high angular rates, and Coordination of motion control.

PHASE II: Develop a detailed design which satisfactorily address critical design issues mentioned above and uncovered during the Phase-I feasibility analysis.

PHASE III: Funding of Phase III expected from various NAVAIR managers.

ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out ARPA's SBIR Program rests with the Office of Administration and Small Business. The ARPA Coordinator for SBIR is Ms. Connie Jacobs. ARPA invites the small business community to send proposals directly to ARPA at the following address:

ARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

ARPA has identified 87 technical topics, numbered ARPA 93-033 through ARPA 93-119, to which small businesses may respond in the second fiscal year (FY) 1993 solicitation (93.2). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 32 technical topics which were numbered ARPA 93-001 through ARPA 93-032. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from ARPA technical offices.

ARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the ARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military, as well as, dual-use applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. ARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II awards are limited to $375,000; however, additional funding may be available for optional tasks.

ARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, ARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the ARPA mission. As a result, ARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to ARPA must have a topic number and can only respond to one topic.

ARPA has prepared a checklist to assist small business activities in responding to ARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to ARPA. Do not include the checklist with your proposal.

ARPA 1993 Phase I SBIR

Checklist

1) Proposal Format

a. Cover Sheet - Appendix A (identify topic number) ______

b. Project Summary - Appendix B ______

c. Identification and Significance of Problem or Opportunity ______

d. Phase I Technical Objectives ______

e. Phase I Work Plan ______

f. Related Work ______

g. Relationship with Future Research and/or Development ______

h. Post Potential Applications ______

i. Key Personnel ______

j. Facilities/Equipment ______

k. Consultants ______

l. Prior, Current, or Pending Support ______

m. Cost Proposal - Appendix C ______

2) Bindings

a. Staple proposals in upper left-hand corner. ______

b. <u>Do not</u> use a cover. ______

c. <u>Do not</u> use special bindings. ______

3) Page Limitation

a. Total for each proposal is 25 pages inclusive of cost proposal (Appendix C) and resumes. ______

b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

a. Original proposal, including signed **RED** Appendices A and B. ______

b. Four photocopies of original proposal, including signed Appendices A and B. ______

c. One additional photocopy of Appendices A and B only. ______

SUBJECT/WORD INDEX TO THE ARPA SBIR SOLICITATION

INDEX OF ARPA FY 93 TOPICS

ARPA 93-064	Development of Interactive Computer-Based Training Programs for Home Use
ARPA 93-065	Low-Cost Techniques to Prevent Enemy Use of Captured Personal Communication Equipment
ARPA 93-066	Low-Cost, Add-On Guidance and Control Concepts for Artillery Projectiles or Rockets
ARPA 93-067	Application of Thermoplastics for Lightweight Survivability
ARPA 93-068	Self-Repairing Materials for Vehicle Survivability and Structural Applications
ARPA 93-069	Smart Materials and Active Structures in Light Combat Vehicles
ARPA 93-070	Parametric Approach to Concept Exploration in Distributed Simulation
ARPA 93-071	Innovative Approaches to Linking Wargames
ARPA 93-072	High-Speed Electrodes for High-Density Optical Guided Wave Devices
ARPA 93-073	Multisensor Inspection for Microelectronics
ARPA 93-074	Residue Number-Based Fast Fourier Transformers (FFTs)
ARPA 93-075	Parallel Infrared (IR) Magneto Mapper for Semiconductor Material
ARPA 93-076	Optical to Electrical Power Conversion Unit
ARPA 93-077	Payout Dynamics Experimental Investigation
ARPA 93-078	Compact Acoustic Plane Wave Generator
ARPA 93-079	Thrust Vector Control (TVC) System for Low-Cost Expendable Turbojet Engines
ARPA 93-080	High-Strength Bend-Insensitive Polarization Maintaining (PM) Fiber Development for Inertial Sensor Applications
ARPA 93-081	Micro-Lasers for Infrared Scene Projection
ARPA 93-082	Automated Bobbin-Baselayer Inspection System
ARPA 93-083	Models for the Growth and Processing of Infrared (IR) Materials
ARPA 93-084	Process Control Technology for Infrared (IR) Materials Growth and Device Fabrication
ARPA 93-085	Processes and Equipment for Advanced Devices
ARPA 93-086	Simulation Tools for Plasma Reactor Synthesis
ARPA 93-087	Chemical Vapor Deposition (CVD) of Next Generation High Density Interconnects
ARPA 93-088	Lenses and Mirror Technology for X-ray Lithography
ARPA 93-089	Stress-Free Membranes for Submicron Stencil Mask
ARPA 93-090	Photoconductive Switch for Reconfigurable Antenna
ARPA 93-091	Simulation, Modeling and Computer Aided Design (CAD) Tools for Optoelectronic Components
ARPA 93-092	Applications Demonstration Utilizing Optical Computing
ARPA 93-093	Lightweight, Hand-Held Gamma Ray Detector with Isotope Identification Readout
ARPA 93-094	Gamma Ray Lens Feasibility Study
ARPA 93-095	Lightweight, Hand-Held Chemical Detector with Chemical Identification Readout
ARPA 93-096	Optimization of Real-Time Communications for a Global Nuclear Proliferation Monitoring System

ARPA 93-097	Assessment of Techniques for Nuclear Testing that Evade Detection, and Development of Monitoring Approaches to Counter such Evasion Attempts
ARPA 93-098	Laboratory and Theoretical research to Predict Decoupling Effects for Various Comprehensive Test Ban Treaty Evasion Schemes
ARPA 93-099	Photonic Radar Systems
ARPA 93-100	Interference Rejection and Angle Estimation Techniques for Antenna Arrays with Uncertain Element Locations
ARPA 93-101	Electrooptic Materials Development
ARPA 93-102	Develop Ground Bounce Jammer Mitigation Techniques for Communication and Radar Systems Implementation
ARPA 93-103	Lattice Wing Technology for Maneuverable Towed Bodies
ARPA 93-104	Photonic Hybrid Devices for Radar and Communications Systems
ARPA 93-105	Knowledge Query and Manipulation Language (KQML) Interfaces
ARPA 93-106	Methods to Extract Annotations from Engineering Drawings and/or Maps
ARPA 93-107	Methods, Support, and Languages to Control, Access, and Integrate Results of Simulation Programs from Remote Systems
ARPA 93-108	Means to Facilitate Access to Public or Semi-Public Databases from Remote Systems
ARPA 93-109	Advanced Multimedia Imaging Helmets
ARPA 93-110	Intelligent Robotic Cranes and Fixtures for Manufacturing of Ship and Ship Systems
ARPA 93-111	Advanced Marine Internal Combustion Engines
ARPA 93-112	Intelligent Planning and Control Systems for Rapid Response and Mitigation of Maritime Oil Spills
ARPA 93-113	Advanced Embedded Sensors and Intelligent Control Systems for Internal Combustion Engine Performance Monitoring and Control
ARPA 93-114	Dolphin/Bat Signal Processor and Classifier
ARPA 93-115	Dolphin Sonar Transducer and Array
ARPA 93-116	Sensors and Technologies for Fiber-Optic Sensing Systems
ARPA 93-117	High-Density and Safe Storage for Unmanned Undersea Vehicles and Electric Land Vehicles
ARPA 93-118	Compact and Efficient Reformer to Supply Hydrogen for Proton Exchange Membrane (PEM) Fuel Cell Stacks
ARPA 93-119	Components for Low-Cost, High-Performance and Robust Proton Exchange Membrane (PEM) Fuel Cells

ARPA 93-033 TITLE: Innovative Approaches to the Design of Visually Covert Low-Power, Low-Gain Antennas in the Range of 2-2000 MHz

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Design, simulate, implement and demonstrate a family of small, covertly-concealable, mobile receiving and/or transmitting antennas, covering selected portions of the 2-2000 MHz band.

DESCRIPTION: Concepts are sought for a family of small, visually-covert antennas that can be installed in mobile platforms such as automobiles, trucks, aircraft, trains, boats or shipping containers to provide transmission of position and other information about the state of the mobile platform. The antennas must also be capable of receiving command messages and transmitting state data to a command center. The antennas should cover selected portions of the HF, VHF and UHF frequency bands. HF includes near-vertical incidence and long-range capabilities. VHF includes meteor burst communication, line of sight and diffraction/mixed modes. There are two classes of antennas to be considered: Class (1) where modest preparation of the mobile platform is permitted before use; Class (2) where little to no preparation of the mobile platform is permitted before use. The maximum peak power to be transmitted is 20 watts. For reception in the lower VHF and HF bands, the receiving sensitivity should be no worse than quasi-minimum or Galactic noise, whichever is greater. Criteria for evaluating competitive designs will include efficiency, covertness to visual detection, ease of installation into a variety of platform types (different designs for each type of platform and frequency band are acceptable), ruggedness and gain. Designs for directional antennas shall include the means at both ends of a communication link for tracking the command station.

Phase I: Design a family of antennas to support the description above. Model and/or simulate the performance of the antennas. Generate a report that: analyzes the efficiency of each of the antennas, includes graphics showing the way covertness will be achieved and how installation in each of the types of mobile platforms will be performed, and shows antenna patterns in the vertical and horizontal planes over the band of frequencies selected.

Phase II: Implement a mutually agreeable set of full-scale antennas. Deliver and support the installation of the antennas into a selected subset of government-furnished mobile platforms. Prepare a test plan for the evaluation of the communication performance of the antennas as installed in a selected subset of mobile platforms. The other portion of the communication system will be provided by the government. Support the field test with personnel and/or automated data collection capabilities at up to three test sites simultaneously, at least one of which will be mobile. Prepare a final report on the field tests.

ARPA 93-034 TITLE: Innovative Approaches to Radar Detection of Underground Targets

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Investigate and demonstrate innovative approaches for the detection and recognition of underground targets with radar systems.

DESCRIPTION: The detection of underground targets has long been an area of active interest to the DoD and, more recently, to various civil agencies for law enforcement and environmental purposes. Radar has always been a sensor of interest because of the earth penetration properties of low-frequency radiation and the inherent potential for day/night, high search rate, highly automated imaging systems. Despite these characteristics, high-performance systems have not been produced because of various implementation challenges, physical limitations, and difficulty in the recognition of targets and suppression of surface and subsurface clutter. In light of advances in radar technology, signal processing, and automated image processing, ARPA is interested in innovative concepts which may offer useful performance. All target classes are of interest, ranging from small objects at shallow depths, such as mines, through intermediate targets such as arms caches, to very large underground facilities at perhaps great depths. Surface conditions may range from desert to foliated and rough terrain. Topics of interest include complete system concepts, radar subsystems or components which offer some unique contribution to underground target detection, and signal or image processing techniques which enhance target detection/recognition and aid in clutter suppression. System concepts may include airborne or ground-based, vehicle-mounted or non-portable radars. Though such systems are likely to operate at lower frequencies, perhaps L-band or lower, and would have bandwidths and cross-range processing approaches commensurate with resolution/target size considerations, alternative techniques and innovative implementations are also of interest.

Phase I: Phase I tasks would generally consist of system design and performance prediction, but could include

laboratory demonstrations or field experiments in relation to critical technical issues.

Phase II: Phase II would include upgraded system design/optimization, with supporting laboratory or field experiments, and the field demonstration/verification of the full system, though not necessarily in an operational configuration.

ARPA 93-035 TITLE: Terrain and Geologic Feature Extraction from Synthetic Aperture Radar (SAR) Imagery

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop techniques to automatically extract terrain and geologic features, including height, from both two-dimensional and three-dimensional SAR imagery.

DESCRIPTION: SARs have been used for a number of years for military and civil applications. ARPA has recently embarked upon a two-pronged technology development effort to extend and enhance performance in these applications through exploitation of interferometric SAR (IFSAR) techniques. IFSAR processing adds a third dimension to SAR products -- elevation -- which enables extraction of Digital Terrain Elevation (DTE) data which can be used in terrain analysis. IFSAR signal processing involves the creation of two or more SAR images simultaneously from different points in space while preserving the relative phases for each pixel in the map. The phase differences between the multiple SAR images can then be used to provide an estimate of the height and/or velocity of each pixel. Thus, IFSAR provides range, cross-range and elevation. This added third dimension allows for the creation of accurate three-dimensional records of the scenes being viewed. In addition to the IFSAR DTE data, the two-dimensional SAR imagery itself provides a valuable product. SAR imagery shows roads, buildings, vehicles and other landmarks. Thus, it should be possible to automatically extract these and other natural and man-made features from the imagery. This extraction is currently done to some limited degree in Automatic Target Recognition (ATR) systems, where the terrain and geologic features are generally classified as clutter. In this case, ARPA is interested in the extraction and identification of classes of terrain and geologic features such as forest type, soil moisture content and surface roughness.

Phase I: Phase I generally consists of developing techniques for automatically extracting terrain and geologic features from SAR imagery, and performance prediction of those techniques. However, it could also include laboratory demonstrations or field experiments in relation to critical technical issues, or for performance prediction.

Phase II: Phase II would include improving upon the techniques identified/developed during Phase I, with supporting laboratory or field experiments, validation of algorithm performance, and the implementation of the extraction techniques in a workstation environment.

ARPA 93-036 TITLE: Modeling and Simulation of Multimedia Transmission Over Wireless Networks

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop models for transmission of multiple data formats (data, image, video, voice) over wireless networks and simulate performance of these models.

DESCRIPTION: Research and develop methods and techniques for multimedia transmission over wireless networks. Hardware and software solutions are sought that are capable of running with general-purpose, scalable computing environments and that can deliver multimedia over limited distances without physical connections (wire or optical fiber). Limitations, domains, and applicability of the approach must be quantified. Demonstrations should be consistent with the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: In detail, define the model, including channel and source coding techniques, interfaces, trade-offs and risks. Expected performance must be estimated, along with comparisons to existing state of the art.

Phase II: Develop, prototype, demonstrate, and deliver the simulator, as well as associated documentation and testing strategy that compare results to predictions.

ARPA 93-037 TITLE: Mobile Connectivity to National Networks

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Explore, develop, and demonstrate innovative methods for providing computer networking access and services between mobile hosts and the National Research and Education Network (NREN).

DESCRIPTION: Research and develop innovative wireless communication technologies, network protocols interfacing mobile host computers to the NREN, file services and other utilities, for use by detached hosts who are outside of the relevant service area(s). While inside the service area, it is required that network connectivity be maintained while hosts are permitted to relocate at pedestrian speeds or faster. Preference will by given to approaches that exploit existing standards, such as network protocols and file system interfaces, and which exhibit potential for scaling to large numbers of hosts. Specifically excluded are technologies and protocols that are limited to in-building replacement of conventional network cabling between desktop computers.

Phase I: In detail, define the candidate communications technology, network protocols, file services and utilities, technical approaches, interfaces, trade-offs, and risks in comparison to existing approaches, along with supporting evidence of success, such as early feasibility analyses or prototyping experiments.

Phase II: Prototype, develop, demonstrate, evaluate and deliver network interfaces, protocol implementations, or file services and utilities along with associated documentation and evidence or performance evaluations that compare results to original predictions.

ARPA 93-038 TITLE: Security Protocol Design for Networks

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and prototype novel and effective computer/network security protocols and tools for use within the Internet environment.

DESCRIPTION: General -- Concepts are sought for innovative and novel ideas and implementation of protocols that enhance secure or high-assurance computer operation over computer networks. Protocols may be targeted at various network applications including, but not limited to, secure implementation of: network management, electronic mail, remote login, remote procedure calls, distributed file systems, and multi-media. Tools include, but are not limited to, implementation of privacy and authentication techniques, and cryptographic techniques. Implementations may be targeted at workstation-class machines or scalable high-performance computing platforms with Unix, Posix or Mach-based operating systems. Protocols should be targeted for use within the Internet. Interfaces to protocols must be open and non-proprietary, as well as suitable for publication as Internet Request For Comment (RFC).

Phase I: Provide a detailed specification of the proposed protocol (including a draft RFC suitable for general comment), tool, or algorithm. Describe new or novel ideas or concepts. Describe the concept's or idea's key features. Demonstrate or describe how the new protocol, tool, or algorithm would be used. Finally, describe the path or process for implementation within one of it's intended target platforms.

Phase II: Develop the protocol, tool, or algorithm that implements the new technology, concept, or idea. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes how to use it, any external interfaces or requirements, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in Unix Tar format, with all sources in ASCII.

ARPA 93-039 TITLE: Scalable Accelerators and Interfaces for High-Performance Computing Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and quantify performance of specific hardware/software accelerators that will operate as part of a scalable high-performance computing system environment.

DESCRIPTION: Research and development of specific, small-scale, hardware accelerators or techniques is sought. Hardware and software solutions, capable of running in collaboration with general-purpose scalable computing

environments, are sought which can accelerate classes of computational problems by 2-3 orders of magnitude over general-purpose solutions. The ability to rapidly prototype the accelerators is essential. Preference will be given to approaches exploiting existing standards, open interfaces, and future-generation scalable technologies. Limitations, domains, and applicability of these approaches must be quantified. Demonstrations should be consistent with the goals of the Federal High Performance Computing and Communications (HPCC) program, and be focused on high-payoff application areas.

Phase I: In detail, define the candidate accelerator, technical approaches, interfaces, trade-offs, and risks, along with supporting evidence of success, such as early prototyping experiments. Comparisons should be made to existing state of the art, and expected performance should be related to trends and general-purpose solutions.

Phase II: Prototype, develop, demonstrate, and deliver the accelerator, as well as associated documentation and testing strategy that compare results to predictions.

ARPA 93-040 TITLE: System and Technology Computer Aided Design (CAD) on a Scalable Computing Base

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Research and develop new algorithms to support computing system and electronic technology CAD that can potentially execute on both workstations and massively parallel computers.

DESCRIPTION: New algorithm families implemented in design tools are sought for use in approaches that will lead to innovations in Technology Computer Aided Design (TCAD) and to the design of new computing systems. These algorithms will provide the design foundation for the next generation of advanced electronic devices, processes, and microsystem components, and thus they must be capable of executing on diverse computing systems that range from workstations to massively parallel computers. Such algorithms should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: In detail, define the application, algorithm(s), trade-offs, and comparison with existing approaches, and provide supporting evidence of success, such as early prototyping experiments or simulation results.

Phase II: Develop and demonstrate a tool implementing the algorithm and provide supporting documentation and test cases which clearly demonstrate its feasibility. Evidence that it is capable of running and performing for scalable parallel computing purposes is required.

ARPA 93-041 TITLE: Software Technologies for Advanced High-Performance Computing Environments

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Explore novel ideas for advancing scalable high-performance computing environments to dramatically improve programming and user productivity.

DESCRIPTION: General -- Concepts are sought for innovative ideas to advance high-performance computing environments. The list of desired advancements/developments includes, but is not limited to, compiling technology for scalable parallel computers; tools to support development of scalable parallel programs; tools for visualizing, measuring, profiling, analyzing, and debugging parallel programs; run-time system technology, tools, or libraries; scalable algorithms for application software library modules; and novel concepts for supporting scalability in either run-time or application libraries. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces. Focus should be on scalable computing systems. Collaboration with ongoing research in academia, government laboratories, or industry is encouraged.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe the concept's or idea's key features. Demonstrate or describe how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on advanced processors or scalable parallel systems.

Phase II: Develop the software prototype, subsystem, or module which implements the new technology, concept, or idea. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

ARPA 93-042 TITLE: Integrated Computer Aided Design (CAD) Package for Designing Precision Antennas

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a CAD package for the design of antennas which must simultaneously meet stringent electromagnetic, mechanical, and environmental requirements. The CAD package is to use a common representation of the antenna for conducting engineering trade-offs between electromagnetic and environmental requirements.

DESCRIPTION: CAD packages exist that permit the design of many types of antennas to satisfy very precise electromagnetic requirements with respect to pattern, input impedance, etc. In many defense requirements, the antennas are subject to severe environmental conditions, and these conditions can significantly affect antenna performance. While CAD packages exist that permit determination of changes in antenna physical properties (dimensions, temperature, etc.), these changes are not related to electromagnetic properties without extensive additional analysis and data reformatting. This project will select one or more small antenna types, as are commonly used for array elements or alone, and then determine suitable analysis methods for the antennas' electromagnetic, mechanical, and thermal properties. The analysis methods should be able to use a common representation of the antenna. A design methodology will be developed that uses sensitivity analyses of the effects of mechanical stress, temperature changes, etc., on antenna electromagnetic performance to form the foundation for trade-off studies, which culminate with antenna designs that are insensitive to environmental effects. The resulting CAD package should be designed for use in a workstation environment. Also, the resulting CAD package should have its calculation results extensively validated, and should compare computed results to experimental data. At the end of the project, one or more antennas shall be designed, fabricated, and tested to demonstrate the utility of the CAD package.

Phase I: Select antenna type(s) to be the focus of the proposed CAD package. Determine analysis methods to be used for electromagnetic, mechanical, and thermal properties of the antenna(s), and the design representation which will be common to all analyses. Determine design methodology and method of doing sensitivity analyses and trade-offs, and develop the CAD package's architecture. Identify the availability of experimental data for validation of calculations, and develop a validation plan. Identify the antenna type(s) to be built for validation under Phase II. Demonstrate the appropriateness of the selected analysis methods, design representation, and design methodology by running test-case designs using existing nonintegrated methods.

Phase II: Using the results of Phase I, develop an integrated CAD package and associated user documentation, conduct the validation plan, and design, build, and test the antenna type(s) selected for CAD package validation under Phase I.

ARPA 93-043 TITLE: Low-Cost Fiber Optics to Computer Interface

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and test a fiber-optic cable to Personal Computer (PC) connector technology that could be mass produced and installed for a price comparable to that of a coaxial cable connection.

DESCRIPTION: Fiber-optic local area networks offer great potential for improving the capability of deployable military command and control systems because they permit improved performance, while at the same time reducing volume and weight. Unfortunately, the difficulty and expense of making fiber-optic connections is a deterrent. Existing fiber-optic connection techniques are expensive, tend to be fragile, often require careful alignment, and are susceptible to dirt. The goal of this project is to seek innovative methods for overcoming the drawbacks of fiber-optic connections as applied to small computers (eg. PCs). Emphasis should be placed on reducing the cost per connection (when bought in bulk) to a cost comparable to that of conventional coaxial connections.

Phase I: Develop several innovative methods for connecting an optical fiber to a small computer when the optical fiber is to support a standard local area network, and analyze their expected performance and projected cost. Based on the results of the analysis, select the most promising concept for further investigation.

Phase II: Build and test a prototype of the connector concept selected in Phase I and validate the assumptions made in the Phase I analyses.

ARPA 93-044 TITLE: Integrated Micromechanical Sensors and Actuators for Vibration Control

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop an integrated system using micromechanical sensors and micromechanical actuators that can control the lower-order vibrational modes of a rotating shaft or of a thin plate or membrane.

DESCRIPTION: Micromechanical sensors have been developed to the point of widespread practical application, and micromechanical actuators have been demonstrated in the laboratory. As a result, great potential exists for novel systems and applications arising from combining these two elements in integrated systems. In order to explore this potential, this program will develop an integrated micromechanical sensor/actuator system that can control the lower-order vibrational modes of either a rotating shaft or of a thin flat plate or membrane. The intended final application is either to permit higher-speed operation of rotating machinery, or to reduce acoustic noise radiated by a machinery enclosure.

Phase I: Develop architectural concepts for an integrated micromechanical system, model and simulate their performance, and examine suitable manufacturing processes for systems for both of the proposed cases (rotating shaft and flat plate). Based on these results, decide on a particular concept to be developed in Phase II and document the rationale for the choice.

Phase II: Develop a detailed design for the concept selected in Phase I, and fabricate and test a prototype.

ARPA 93-045 TITLE: Automated Generation of Electromagnetic Computer Aided Design (CAD) Package Computational Meshes

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop one or more algorithms for the automated generation of computational meshes used for solving numerical electromagnetics problems, and an associated methodology for assessing the computational errors associated with the automatically-generated mesh.

DESCRIPTION: Numerical electromagnetics analysis capabilities have significantly increased in the past decade due to the availability of high-performance computers and the development of several effective analysis methods (Method of Moments, finite elements, finite difference, time domain, etc.). However, application of numerical electromagnetics analysis methods to complex or large objects requires extensive geometric modeling of the object followed by definition of the appropriate computational mesh. Due to the nature of electromagnetics problems, automatic mesh generators developed for other applications (mechanical design, computational fluid dynamics, etc.) are not well adapted to electromagnetics problems that require hand refinement of the meshes. This project is to develop one or more algorithms (Method of Moments, finite elements, etc.), starting from a CAD file description of a complex object, and to develop an accompanying error analysis, relating features of the automatically generated computational meshes to errors in the subsequent numerical electromagnetics calculations. The capabilities of the developed algorithms will be assessed by using them to calculate electromagnetic quantities for complex objects for which theoretical results and/or experimental data exists, and then comparing the calculated results with the theoretical and/or experimental results.

Phase I: Survey automatic mesh-generation algorithms and numerical electromagnetics algorithms. Analyze the effects of computational mesh properties on numerical electromagnetics errors, and select one or more combinations of mesh-generation/numerical electromagnetics algorithms for development and refinement. Develop a plan for validating and demonstrating the performance of the selected mesh-generation/numerical electromagnetics combination using theoretical and experimental results. Conduct a preliminary assessment of the selected mesh-generation/numerical electromagnetics combination.

Phase II: Complete development of the selected mesh-generation algorithm, resulting in an executable computer code. Complete development and documentation of the error analysis relating automatically-generated mesh properties to subsequent numerical electromagnetics calculation errors. Conduct the validation and demonstration plan developed under Phase I.

ARPA 93-046 TITLE: Encapsulated Sensing Subsystems for Telemetry and Remote Control

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a sensor encapsulation system and associated data telemetry which permit selected physical variables to be remotely sensed in hazardous or inaccessible locations and the resultant measurements to be processed by standard instrumentation.

DESCRIPTION: The properties of advanced materials could be improved and their cost reduced if the manufacturing process was under closed-loop control. This project is to establish the feasibility of developing a family of sensors which could measure and provide feedback on material properties and/or process variables, while directly accompanying material samples through the manufacturing process. The sensors would be encapsulated to withstand the environmental stresses associated with taking *in situ* measurements, would provide outputs compatible with existing information-processing equipment and standards, would be self-contained (providing their own power source), and would use a wireless telemetry system to report their measurements. The intent is to minimize interfaces and supporting equipment needed to use the sensors. The sensors' conceptual design should seek to minimize the expected cost of producing the sensors, so that reuse is not required in order to achieve economic feasibility, and so that sensor maintenance would be minimal. The project will select a single materials manufacturing process and two or three physical or chemical measurements to use while investigating the concept's feasibility. If feasible, the initial phase would be followed by the building and testing of a small number of prototype sensors.

Phase I: Determine a candidate materials manufacturing process and physical and/or chemical measurements to be performed. Define the operational environment of the sensor package. Based on this information, develop a conceptual design for the encapsulated sensor system, which should include sensor mechanisms, calibration requirements and procedures, power source, telemetry and control, environmental encapsulation concept, and interface with standard information-processing equipment.

Phase II: Develop and test prototype encapsulated sensors based on the conceptual design of Phase I.

ARPA 93-047 TITLE: Solid Freeform Fabrication

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop and demonstrate the machine capability to produce functional prototypes directly from Computer Aided Design (CAD) files without part-specific tooling or operator intervention. Materials of interest include: monolithic structural ceramics, fiber composites, and Functionally Gradient Materials (FGMs).

DESCRIPTION: The choice of materials for construction is made at the system level, in most cases at the preliminary design stage. At this stage, advanced materials are at a distinct disadvantage relative to lower-cost commodity materials that are often available in billet stock form which can be fabricated into finished prototypes with readily available machine-shop capabilities. Solid Freeform Manufacturing (SFF) is commercially available for plastics, where it is used for 'form and fit' and, increasingly, for low-cost rapid tooling. Extending this technology to functional prototypes made from monolithic structural ceramics, fiber composites, or FGMs will help make these materials more user friendly to the system-level designer by reducing the time and cost of producing functional prototypes. To be of greatest benefit, the material properties (strength, elastic modulus, fracture toughness, etc.) obtained by using the SFF capability must match those obtained by using the conventional manufacturing methods which would be used for high-volume production of the prototyped parts. Extension of the machine capability to components or devices for which the composition will vary spatially is also of interest.

Phase I: Demonstrate the SFF machine capability for the fabrication of functional prototypes from monolithic structural ceramics, fiber composites, or FGMs. Demonstrate both the ability to fabricate near-net-shape components, and that the strength of the materials produced is comparable to that of materials fabricated by conventional methods.

Phase II: Expand upon the machine capability demonstrated in Phase I to determine the effect of machine operating conditions on part tolerances, material microstructure/property relationships (including strength), component build rate, and component costs.

ARPA 93-048 TITLE: Integration of Large-Scale Simulation and Controls

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop methods for control of physical processes, especially complex processes occurring during materials processing, which employ physically-faithful simulations in the construction of models.

DESCRIPTION: Considerable effort has been spent developing simulation codes for a variety of complex physical processes. Recently, experience developing computational fluid dynamics and combustion codes has been applied to efforts to develop codes that simulate a variety of complex physical processes, such as those occurring in processing of materials (e.g., chemical vapor deposition). Such codes will prove useful for design of processes and in testing. However, many such processes require on-line control to achieve processing requirements and, while models exist for many of the complex processes of interest and simulation codes are being developed, novel approaches may nonetheless be required in order to use this information to develop robust methods for sensor-based feedback control. ARPA seeks novel approaches, based on physical models and/or large-scale simulations, to development of sensor-based feedback control methods for manufacturing or materials processes of interest. Work should focus on the interface between physically-faithful computational simulations and on-line control. Two features need to be addressed: development of appropriate software tools and validation on at least one process of interest to DoD. In addition, it is desireable that this be done within an analytic framework to enable an assessment of robustness, modeling error, and effect on control.

Phase I: Develop a methodology for constructing sensor-based feedback controls using large-scale simulations. Development should focus on a problem in materials processing of critical interest to DoD. Demonstrate the methodology's feasibility.

Phase II: Develop algorithms and software, demonstrate approach, and validate on specific process.

ARPA 93-049 TITLE: Flexible Manufacturing of Laser Diode Arrays

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop flexible manufacturing methods for laser diode arrays in integrated packages for many applications. Manufacturing processes should reduce the cost associated with making different types of packages.

DESCRIPTION: Laser diode technology has matured in many ways over the last several years. The device performance has increased dramatically, enabling many different types of applications. These applications cover a wide range of performance and architectural requirements. The thermal and optical systems that are an integral part of the package are driven into quite different regimes depending on the specific application. For example, the duty factor, which can range from 10 Hz to CW, would require many different types of coolers. Similarly, in optical subsystems the requirements range from no optical elements to complicated arrangements of microlenses and fiber coupling requiring precision assembly. A flexible manufacturing approach that would allow all the package architectures to be produced on the same manufacturing line would reduce the cost of producing different types of packages. Rather than having multiple fixturing and tooling for each type of package, a flexible line would allow most of the assembly to be done with the same tooling system.

Phase I: Assess both DoD and commercial applications in terms of requirements on package architectures and recommend ways in which a flexible manufacturing process would reduce the cost associated with making laser diode array packages incorporating different types of cooling systems and optical systems.

Phase II: Implement the concepts developed in Phase I into a common manufacturing line and demonstrate cost reductions.

ARPA 93-050 TITLE: Innovative Applications of Fiber Optics in Biomedical Technology

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Broaden the use of fiber optics in biomedical technology.

DESCRIPTION: Fiber optics has emerged as the key technology in the next generation of telecommunications. Its success is due to many of its characteristics, including its: high bandwidth, high efficiency, compactness, light weight and

flexibility. In the biomedical area, fiber optics have successfully been used for endoscopic surgery and photo dynamic therapy. However, the potential uses for fiber optics in the biomedical arena are still largely untapped. For example, in endoscopic surgery a three-dimensional image is still lacking. By taking advantage of the physical properties of fiber optics (compactness and flexibility) and combining it with modern optics and advanced software algorithm, a three-dimensional image of the surgical area could be generated. Fiber optics might also be used in conjunction with frequency tunable lasers for example, diode-pumped solid-state lasers, to deliver laser energy with the appropriate wavelength to desired tissue or organs. In addition, the high bandwidth property of fiber optics is not yet used in biomedical technology.

Phase I: Conduct a trade-off study of fiber optics for one or more specific areas of application in biomedical technology. A projection of technical and cost benefits and a program plan are required. Include some discussion about the transition to that technology.

Phase II: Conduct a proof-of-principle demonstration of idea(s), initially in the laboratory with a follow-up demonstration in a testbed or, preferably, in a medical facility.

ARPA 93-051 TITLE: Efficient Processing of Logistic Fuels for Military Fuel Cells

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Explore innovative ideas for more efficient processing of logistic fuel for militarized fuel cells.

DESCRIPTION: Depending on the particular fuel cell technology involved, today's fuel cells operate on either pure gaseous hydrogen, or on mixtures of hydrogen and carbon dioxide with small amounts of carbon monoxide and sulphur impurities tolerated. Large-scale use within the Military depends on the development of an efficient method for converting common logistic fuels, i.e. DF-2 and JP-8, into such a gaseous fuel mixture. Proposals are sought for new and innovative approaches to pre-processing these fuels for use in conventional steam reformers and for novel overall processing concepts that maximize fuel conversion and power system efficiency. Proposals should discuss the application of the proposed concept to the major fuel cell technologies under development and concepts that apply to more than one of the major fuel cell technologies will be favored. Other considerations that should be discussed include: fundamental materials issues, transient response, part-load efficiency, emissions, economics, and life-limiting factors.

Phase I: Submit preliminary fuel-processing system designs, performance thermodynamic and heat transfer analysis of design concept. Experimentally demonstrate critical features at laboratory scale.

Phase II: Design, fabricate and test a brassboard fuel processing system to demonstrate and quantify the system benefits of the concept. The test unit should be sized and constructed to be compatible with a $\geq$ 10 kw fuel cell.

ARPA 93-052 TITLE: Medical Technology: Diagnostics, Intervention and Dynamic Health Assessment

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and further exploit the defense technology and knowledge base in an effort to revolutionize the quality and delivery of health care and to reduce aggregate health care costs.

DESCRIPTION: Advances in key DoD technology-base areas (e.g. sensors, simulations, communications, information processing, and mathematical analysis) suggest a unique opportunity to significantly enhance the quality and delivery of health care to both U.S. combatants and the civilian population. Proposals are invited that would significantly improve capabilities in: (1) minimally invasive diagnostics, (2) point and remote care delivery, (3) training of physicians and combat medics, (4) dynamic health assessment (embedded outcomes analysis), and (5) resource allocation.

Phase I: Develop proposals which identify novel methodological and technological concepts and focus efforts on central research issues with reasonable proof of technical progress.

Phase II: Provide initial proof-of-concept demonstrations.

ARPA 93-053 TITLE: Carbon Fiber/Polymer Matrix Pultruded Composite Structure

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop and demonstrate that pultrusion technology using carbon fiber and a polymer matrix can be cost effective in high-performance structural shapes for commercial and military aerospace applications.

DESCRIPTION: The major barrier to broader use of advanced composite materials is cost. Increased emphasis must be placed on low-cost manufacturing technologies. Pultrusion technology using fiberglass reinforcements is a well-developed cost-effective process in use in a variety of industrial applications and has shown potential for use in commercial and military aerospace applications. Additional effort is required to develop this technology and demonstrate its appropriateness for aerospace applications.

Phase I: Select two or more shapes that are suitable for commercial and military applications where pultrusion may offer significant cost savings. Develop a plan to extend the current technology by using carbon fiber as reinforcement and demonstrate the carbon fiber process in selected structural shapes. Input from an aerospace prime contractor will likely be beneficial in selecting the structural shapes.

Phase II: Perform required development work and demonstrate the technology and projected savings in full-scale structure on production equipment.

ARPA 93-054 TITLE: Indium Phosphide Material for Microwave and Millimeter-Wave Monolithic Integrated Circuits

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Advance the development and fabrication of indium phosphide substrates and epitaxial material for microwave and millimeter-wave monolithic format devices and circuits. The material desired will lead to devices and circuits with performance characteristics superior to those fabricated from gallium arsenide.

DESCRIPTION: Gallium arsenide is the most common material that is suitable for use in developing microwave and millimeter-wave devices and monolithic format integrated circuits. However, superior performance characteristics have been achieved using indium phosphide as a substrate material, particularly at millimeter-wave frequencies. Nevertheless, indium phosphide material growth is at an embryonic stage of development and established sources of large-diameter (three-inch diameter or greater) indium phosphide wafers are not yet available. This project is directed toward the improvement of the characteristics of indium phosphide substrate material and substrate/epitaxial combinations that will result in devices and circuits with superior performance at microwave and millimeter-wave frequencies. It is expected that this project will also lead to the establishment of sources of supply for large-diameter (three-inch or greater) indium phosphide wafers with characteristics suitable for high-performance and low-cost microwave and millimeter-wave device and circuit development.

Phase I. Develop cost-effective techniques for producing indium phosphide substrate material and/or indium phosphide substrate/epitaxial material combinations that will result in material with characteristics suitable for yielding high-performance microwave and millimeter-wave devices and circuits. Perform initial growth runs to demonstrate the validity of the selected approach.

Phase II: Perform appropriate work to fabricate indium phosphide substrate material or substrate/epitaxial combinations with the characteristics described above. Focus upon material with three-inch or greater diameter. Employ approaches that will lead to the capabilities for producing large quantities of high-quality material at a low cost.

ARPA 93-055 TITLE: Quasi-Optical Millimeter-Wave Circuits

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop quasi-optical millimeter-wave frequency circuits that have superior performance characteristics to conventional millimeter-wave monolithic integrated circuits.

DESCRIPTION: Quasi-optical components have been developed that have the potential for being produced at low cost and for providing promising performance at millimeter-wave frequencies. However, additional work must be performed to achieve higher power outputs and efficiency, to achieve greater levels of integration and to develop techniques and

capabilities for low-cost production.

Phase I: Identify promising approaches for producing quasi-optical components such as millimeter-wave power sources, power amplifiers, mixers, low-noise amplifiers, or combinations of these circuits. Focus upon approaches that will result in batch fabrication capabilities leading to low-cost manufacturing. If possible, produce initial circuit samples and evaluate them for millimeter-wave performance characteristics.

Phase II: Continue development of quasi-optical millimeter-wave frequency circuits with emphasis on low-cost production. Evaluate yield and millimeter-wave performance of components that are produced.

ARPA 93-056 TITLE: Modeling of Millimeter-Wave Monolithic Integrated Circuits

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Provide models for millimeter-wave monolithic integrated circuits, particularly those fabricated from indium phosphide. Emphasis should be placed on the development of models that accurately predict device/circuit performance from processing parameters.

DESCRIPTION: General - Millimeter-wave devices and integrated circuits fabricated from indium phosphide show excellent performance characteristics. However, in order to accurately and inexpensively develop more complex integrated circuits, accurate models are needed. This program focuses upon the development of these models with particular interest on models for high-power amplifier circuits fabricated from indium phosphide. Most desirable are models which can be used to relate processing parameters to circuit design parameters.

Phase I: Select one or more devices or integrated circuit configurations, preferably ones fabricated from indium phosphide, that operate at frequencies between 20 and 100 GHz. Develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements for the model. Consideration should be given to how models proposed will extend Computer Aided Design (CAD) capabilities beyond those afforded by use of currently existing models and the compatibility of the models with existing commercially supported software packages and workstations.

Phase II: Complete model development and write appropriate software descriptions that can be used in conjunction with commercially supported software and workstations. It should be a goal to produce commercial software products for sale by an established microwave CAD vendor so that they can be used by the widest possible number of people.

ARPA 93-057 TITLE: Biomedical Sensors

CATEGORY: 6.1 Basic Research

OBJECTIVE: Research and development of unobtrusive, portable biomedical sensors for vital-signs monitoring along with the associated signal processing and recording electronics.

DESCRIPTION: Defensive and offensive systems to ascertain the nature and extent of external threats (battle activity, chemical and biological agents, environmental conditions or infectious diseases) are numerous, while no systems exist to objectively determine the physical and psychological condition (fatigue, dehydration, nutrition, stress, illness or injury) of individual combatants or units. Biomedical sensors will bridge this gap and bring together elements of sensors and embedded electronics to develop unobtrusive biomedical sensors which will monitor, process, and report vital signs of mobile, active individuals. Future phases of the biomedical electronics program will incorporate the developed sensors with voice/video communication to field systems that would provide distributed medical aid. Such systems would move medical technology further towards the active area and use shared, visual environments to enable physicians at remote sites to supervise multiple medics closer to the casualties. By improving both the level and timeliness of medical attention, the treatment and survival rate of casualties will be improved. Existing biomedical sensor technology is driven by the needs of the civilian medical care industry which assumes passive/stationary individuals, invasive sensors, and ill or injured patients. The sensors envisioned under this program assume active/mobile individuals, unobtrusive sensors and healthy/uninjured individuals. Biomedical sensor research programs under current support are primarily disease-specific, invasive sensors. The sensors developed under this program would exploit new approaches and extend sensing technology to develop unobtrusive, wearable biomedical sensors that monitor vital signs of usually healthy individuals. Unobtrusive, wearable vital-sign sensors could be used in the civilian sector to improve emergency care delivery, allow for earlier discharge

(reduced health care cost), and improve outpatient care.

Phase I: Explore and demonstrate new approaches (blood oxygen level monitoring via non-invasive blood-color sensing, processing of acoustic signals in arteries to determine blood pressure) that extend sensing technology to develop unobtrusive, wearable biomedical sensors that monitor vital signs of usually healthy individuals.

Phase II: Merger of independent, single biomedical sensors into a vital-signs monitoring suite of sensors. Integration of sensors with voice/video communications and recording modules. Field-testing and data collection from multiple individual sensor suites monitoring a collection of vital signs. Collation and analysis of normative data under a variety of physical and psychological tasks.

ARPA 93-058 TITLE: Agile, Laminar Fabrication of Mixed-Material Structures

CATEGORY: 6.1 Basic Research

OBJECTIVE: Solve important electronics assembly and packaging problems by eliminating the assembly and packaging steps using laminar fabrication techniques.

DESCRIPTION: Assembly and packaging continue to present challenges in developing, fielding and commercializing new devices and systems. Different approaches, ranging from design for assembly to automated robotic assembly, have been offered as solutions to what is essentially a vestigial, manual assembly step. Along with the dramatic size reductions in microelectronic devices, there have been equally dramatic developments and refinements in microelectronic device fabrication. The electronics industry successfully solved the discrete component assembly problem by incorporating both the components and the interconnections (assembly) into the device fabrication process. The manufacturing features that are primarily responsible for enabling device and system complexity in microelectronics are: batch processing of multiple (millions) of components on the same substrate, assembled (connected) components as part of the fabrication process, mixed materials (e.g. ceramics, metals, polymers), common deposition/removal processes for the mixed materials (e.g. plasma etching, chemical vapor deposition), and sub-micron photolithographic feature definition and registration. Except for the photolithographic steps in the sequence, all other aspects of the microelectronic manufacturing process (batch processing, mixed material, common deposition/removal processes, feature definition/registration) can be applied to the fabrication of non-micro and non-electronic components and systems.

Phase I: Identify and demonstrate new materials, processes, and design methods for laminar manufacturing, including: advances in macro-scale, thick-film material deposition/removal techniques, conformal feature patterning, pattern-transfer schemes (mask generation and registration), maskless pattern transfer schemes, and the development of common processing techniques and equipment.

Phase II: Demonstrate prototype manufacturing cells capable of rapid, laminar fabrication of mixed-materials relevant to electronics packaging and assembly needs.

ARPA 93-059 TITLE: Distributed, Unattended Sensor Networks

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop wide-area surveillance using distributed, unattended sensors communicating over wireless networks for use in: threat detection and monitoring, border control, environmental and agricultural applications, and process monitoring and control.

DESCRIPTION: Advances in low-energy signal processing and distributed microelectromechanical systems provide an opportunity for very-large-scale distributed systems where: (1) the sensing resolution and dynamic range are minimal and (2) the data rate to or from any particular sensor or device is quite low. Proposals are solicited for research in this area with emphasis placed on sensor network issues, including: wireless interrogation of distributed, low-power sensors; broadcast schemes and devices for the broadcast of power to distributed, normally-off sensors; and integrated, VLSI-process-compatible tuning elements and antennas. Investigations of such systems should be done in the context of high-leverage applications, such as unattended ground sensors or factory/process automation.

Phase I: Identify and demonstrate new low-energy, low-resolution, and low-dynamic range sensors, wireless transponders, or signal-processing techniques suitable for unattended, wide-area surveillance.

Phase II: Demonstrate fielded, wide-area surveillance networks in a prototypical application (unattended sensing

or factory/process automation).

ARPA 93-060 TITLE: Microactuator Arrays for Small-Area Displays

CATEGORY: 6.1 Basic Research

OBJECTIVE: Small-area, low-power visual, auditory and tactile displays in support of portable, embedded information systems for mobile, active individuals.

DESCRIPTION: Recognizing that MEMS (MicroElectroMechanical Systems) is as much a revolution in the fabrication of electromechanical devices as it is a revolution in the size of electromechanical devices, this area will explore new concepts in the integration of multiple devices to form small-area displays for visual, auditory (0.5 cm x 0.5 cm) or tactile (1 cm x 1 cm) information. Microdynamic displays will use high-density (> 10/square centimeter) microactuator arrays to achieve macroscopic action through the coordinated microscopic action of multiple, identical, and relatively simple microactuators. Common requirements for the construction of small-area, low-power displays using microdynamic systems require the development of high-yield, high-uniformity fabrication processes for microactuators; control strategies for inertia-negligible, friction/viscous force-dominated structures; and control of multiple (> 10,000) devices to achieve macroscopic function through coordinated microscopic action. Visual and tactile displays suitable for head-mounted applications and virtual reality/simulation platforms are of particular interest.

Phase I: Identify and demonstrate new concepts for small-area, low-energy, portable displays for visual, auditory and tactile information.

Phase II: Integrate visual, auditory or tactile display into a portable information display device or a head-mounted display platform.

ARPA 93-061 TITLE: Develop Exercise Software to Run on ARPA JANUS-3D Wargame in UNIX Environment

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop example exercises to run on ARPA JANUS-3D for Army National Guard Forward Support Battalions. Further identify approach and level of effort for the development of software that contains all of the functionality for the Forward Support Battalion and its subordinate units.

DESCRIPTION: ARPA intends to demonstrate the functionality of using the JANUS Wargame enhanced with a "stealth" or "flying carpet" capability to train the headquarter's personnel (command and staff elements) of two National Guard Roundout/Roundup Brigades and their subordinate battalions. Each of these brigades includes a Forward Support Battalion which provides logistics, supply, medical and maintenance support to the brigade as well as to maneuver battalions engaged in warfare. Various versions of the JANUS Wargame have been developed and are currently fielded for conducting staff training in the Army, usually in an institutional or schoolhouse setting. These games are primarily designed to train maneuver unit commanders and staff during combat exercises, and thus the Combat Service Support (CSS) functions cannot be realistically practiced by the appropriate Forward Support Battalion personnel. Therefore, a critical part of the brigade does not get exercised or trained. Two recent developments permit JANUS to be used in a more widespread and productive way. First, JANUS is being converted to operate in the UNIX environment, which will enable the game to be affordably hosted on low-cost workstations and high-end personal computers. This new flexibility will make it economically feasible to distribute the necessary hardware to individual operational units. Second, ARPA has developed two versions of a "stealth" or "flying carpet" capability which permits an observer to inconspicuously and freely move around the three-dimensional virtual battlefield during battle and for After Action Review (AAR). Further study is required to determine the most effective training applications for this 3D capability.

Phase I: Develop exercise software for a limited number of critical combat functions which will enable an assessment of the utility of using JANUS-3D for training National Guard Forward Support Battalions, and the training value of the 3D capability. Phase I will produce a report that prioritizes tasks, determines methodology, and gauges the level of effort involved in fully developing JANUS for use in training Forward Support Battalions.

Phase II: Produce either (1) sufficient exercise software to bring the experimental system to full capability or (2) a significant enough portion of the software identified during Phase I to enable a test of the value-added properties of this approach. Phase II would likely be evaluated by an outside party, such as the Army research institute.

ARPA 93-062 TITLE: Develop Low-Cost Reconfigurable Combat Vehicle Simulators for National Guard

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop portable simulators for use in National Guard armories or soldiers' homes that can be reconfigured to emulate various ground combat vehicles, have sufficient selective fidelity to train crew members and can operate on the Defense Simulation Internet (DSI).

DESCRIPTION: The National Guard training audience is widely dispersed in small groups throughout the United States. This dispersion makes the distribution of typical Army simulators too costly to be practical. The situation is further complicated by space limitations in community armories which cannot accommodate large simulator cabinets as well as by the diversity of units stationed at each armory. This project will produce a prototype of a land combat vehicle crew station that can be reconfigured to emulate other vehicles or crew stations and internet with other simulators via DSI. The simulator should have adequate selective fidelity to offer appropriate cues and responses to the crew member being trained. The initial prototype will demonstrate the key functionality (e.g., fire control and target engagement) of a crew station for two different ground vehicles (e.g., M1A1 tank commander station and M2/3 Bradley commander station) and the ability of the device to operate on DSI. For example, many of the gauges and button controls might be represented on interactive screens which could be easily reconfigured by the user (e.g., by selecting the positions and types of gauges using a mouse and menu). Analog controls (e.g., hand grips and pedals) might be selected and placed in a standard mount.

Phase I: Develop one crew station that is reconfigurable to represent two different ground combat vehicles and which operates on DSI. Produce a report that recommends the methodology and estimated effort required to produce two vehicles worth of crew stations and demonstrates full functionality of the two vehicles and their operation on DSI.

Phase II: Produce two full vehicles worth of reconfigurable crew compartments and demonstrate: the ability of the crew compartments to interact, the two vehicles' ability to interact via DSI, and the ability of the two vehicles to be reconfigured into another vehicle with full functionality for training purposes.

ARPA 93-063 TITLE: Artificial Intelligence Mimic/Tutor

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Conduct a literature review and identify how to develop an artificial intelligence program that will identify adult students' idiosyncratic learning styles, organize the types of materials/information/media that compliment each student's preferred learning style, and prepare to coach/offer suggestions to students about learning options available to them.

DESCRIPTION: A review of past research suggests that students taught in a traditional classroom setting perform about two standard deviations below students taught the same subjects in one-on-one tutorials. However, this gap may be narrowed through the use of computer-based learning systems. The best computer-based interactive systems report an improvement over classroom performance of less than one standard deviation (about .8 to be precise). For instruction to be truly individualized, the student needs to be able to control the pace/tempo of instruction, the sequence that instructional/information units are presented, the content of the instructional units and the method used to present them (e.g., demonstration, text, interactive simulation). By the time students have reached adulthood, they have developed preferred ways of learning. Past computer interactive learning programs have permitted the student to control the pace of instruction and to proceed down alternative paths. However, these computer programs do not necessarily compliment the preferred learning styles of adult students. In fact, the term "learning style" has been defined using widely different variables. If a computer program could ascertain a student's preferred way of learning after several trials, then it would be possible for the computer to select and organize the learning materials on a particular topic to compliment the student's learning style. In fact, the program could go so far as to coach the student regarding how best to continue-- much like a tutor would. Artificial intelligence programs exist for indexing a wide variety of learning materials so that databases can be accessed and searched rapidly and the advent of high-speed computers and rapid-access high-volume databases can store and access a wide variety of learning material formats (e.g., audio, video, text, interactive simulations). Unfortunately, an artificial intelligence program that will mimic a student's search methodology and coach the student has not presented itself. This may be the key to closing the gap between tutorial and classroom student performance. Such a capability would make a significant contribution to training National Guard students in a distributed mode and retraining displaced workers. More significantly, such an interactive system could improve the quality of public education and impact the future development of

educational materials and formats.

Phase I: Produce a literature review of learning styles and artificial intelligence program approaches that might solve the above-discussed problem. Prepare a separate report identifying how to develop such a program using military vocational training as the assumed test case.

Phase II: Develop a significant portion of the code in order to test the hypotheses proposed in Phase I. The instructional program(s) developed would be administered to adult military students and scientifically evaluated (probably by the Army Research Institute). Produce a report documenting the code and recommending how to further develop the program and instructional materials.

ARPA 93-064 TITLE: Development of Interactive Computer-Based Training Programs for Home Use

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Identify innovative approaches for the development of interactive computer-based training programs for training National Guard soldiers at home. Target subjects include supply, maintenance, medical, and communications.

DESCRIPTION: National Guard soldiers are stationed in virtually every community throughout the United States. Since most of them have full-time jobs and are only part-time soldiers, they frequently cannot attend courses in residence at Army Training Centers. The use of computer-based instruction in the past has been hampered by the long time it takes to produce courses (e.g., CD/ROM), the cost of producing and distributing courseware, the cost of updating courseware, and difficulty in using courseware. Due to the dispersion of soldiers and the wide variety of training needed, this program seeks innovative ideas which would enable students to receive high-quality instruction at home. It is assumed that computer terminals or workstations could be assigned to students to take home for coursework (assumed cost <$5000 per suite). Breakthroughs in the use of central servers, new methods of producing CD/ROM, or other approaches are sought that will enable the conduct of vocational training that yields the same exit-level performance achieved by students who attend the instruction in residence and receive "hands-on" training experience. The following subject areas have been selected as representative classes of instruction: military supply, maintenance, medical, and communications.

Phase I: Produce a report that identifies innovative ways to deliver high quality vocational instruction in the home and recommended methodology and cost estimates for proceeding to develop a course of instruction selected by the sponsor in collaboration with the proposer during the course of Phase I development. For example, innovations may include new delivery media, breakthroughs in curriculum development that drive down development time and costs compared to current industry standards, new accessing capabilities, or an array of innovations not named.

Phase II: Develop at least one course in a subject area selected by the sponsor for evaluation with accompanying documentation. The instructional program would be scientifically evaluated (e.g., by the Army Research Institute). Include a report on methodology and recommended future action.

ARPA 93-065 TITLE: Low-Cost Techniques to Prevent Enemy Use of Captured Personal Communication Equipment

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop demonstration low-cost, soldier-friendly hardware which effectively prevents enemy exploitation of captured soldier-borne personal communication equipment, especially to obtain unauthorized access to current command and location information.

DESCRIPTION: In the future, each soldier may carry a personal communication and display system that transmits his position, messages, and the positions of his squad members and other nearby units. In addition to encryption (which will be government-furnished), it is essential that this information not fall into enemy hands via captured equipment or soldiers. Physical and electronic safeguards that ensure that secret data cannot be accessed and that the enemy cannot transmit misleading information via captured equipment are required. Devices such as body function sensors, periodic reactivation codes, voice recognition, or a combination of these or other techniques, are envisioned. These safeguards must not impede or place an undue stress or burden on the soldier.

Phase I: The objectives for Phase I are concept refinement, red-team (i.e., countermeasure) assessment, soldier integration analysis, cost estimation, and, to the extent possible, hardware demonstration.

Phase II: Extend the goals of Phase I and add development and demonstration of a complete system and

components in both a laboratory and field environment.

ARPA 93-066 TITLE: Low-Cost, Add-On Guidance and Control Concepts for Artillery Projectiles or Rockets

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and demonstrate low-cost, add-on guidance and control hardware which provides high terminal accuracy (< 10 meters) for mortar, or rocket rounds in the current inventory.

DESCRIPTION: New navigation aids, such as the Global Positioning System, and new communications technologies, such as the cellular telephone, may enable simple but accurate guidance and control systems. If they are sufficiently low cost, these guidance and control systems could be cost effective when applied to current ordnance. Ideally, the device would be simple to install, such as by screwing into the fuze well of an otherwise unmodified round. Given these devices, a soldier on foot should be able to call for fire and be highly confident that the first round will land where he intends it to. This may require some form of designation by the soldier and/or in-flight communication with the round. The system should operate even when the soldier is in a dense jungle or an urban environment.

Phase I: The objectives for Phase I are concept refinement, system analysis, flight simulation, and cost estimation. Demonstration of critical components or technologies is desired.

Phase II: Extend the goals for Phase I and add development and demonstration of the guidance and control system. Flight demonstrations are desired, preferably with the ordnance attached. If this is not possible, convincing demonstrations of system capability must be performed

ARPA 93-067 TITLE: Application of Thermoplastics for Lightweight Survivability

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Investigate the application of thermoplastics to produce an armor material with superior ballistic properties for light and/or ultra-light vehicles/aircraft.

DESCRIPTION: Current armor materials are primarily metals and ceramics. Because of their light weight, ceramics are the armor material of choice for lightweight applications. However, ceramics have limited multi-hit capability. Once a ceramic armor has sustained a hit, its ability to provide protection in that area is severely degraded. In addition, ceramics are considerably more expensive than metals. It is envisioned that thermoplastic materials with ballistic properties could be employed rather than ceramics to provide improved ballistic protection for lightweight applications at a reduced cost. Ideally, after ballistic impact, these materials would exhibit undegraded ballistic properties.

Phase I: Offeror will present theoretical and experimental verification of principle. Offeror will: (1) identify potential materials; (2) provide supporting rationale; and (3) demonstrate materials' ballistic properties.

Phase II: Offeror will demonstrate proof-of-principle. Employing the results of Phase I, offeror will develop and fabricate a quantity of his material to government specification for ballistic evaluation.

ARPA 93-068 TITLE: Self-Repairing Materials for Vehicle Survivability and Structural Applications

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Explore the potential for using self-repairing materials in ballistic applications and, secondarily, explore the load-bearing properties of these materials.

DESCRIPTION: Current armors are primarily made up of metals and ceramics. Unfortunately, both of these classes of materials are rendered useless upon impact. Therefore, in the event of a second ballistic impact in the same location, there will be no protection. In addition, the area surrounding an impact is weakened as well, which extends the area of vulnerability. Furthermore, ballistic impact degrades the structural properties of metals and ceramics are impractical for many purposes due to their limited load-bearing capability. In light of these limitations, it is envisioned that self-repairing materials with both structural and ballistic properties could be employed rather than ceramics or metals. Ideally, after

ballistic impact, the restored materials would exhibit undegraded ballistic and structural properties.

Phase I: Offeror will present theoretical and experimental verification of principle. Offeror will: (1) identify potential materials; (2) provide supporting rationale; and (3) demonstrate materials' ballistic and load-bearing properties, if applicable.

Phase II: Offeror will demonstrate proof-of-principle. Employing the results of Phase I, offeror will develop and fabricate a quantity of his material to government specification for ballistic and structural evaluation.

ARPA 93-069 TITLE: Smart Materials and Active Structures in Light Combat Vehicles

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Apply subject technology to suppress vibration; assess damage; monitor structural and mechanical status and compensate for vibration, wear, aging and damage; monitor and control vehicle signatures such as thermal and acoustic.

DESCRIPTION: Traditional combat vehicles are primarily built of steel or aluminum and weigh up to about 60 tons. Examples are tanks, howitzers, and infantry fighting vehicles on personnel carriers. There is a need for a lighter, smaller vehicle capable of performing other combat missions such as reconnaissance. These light combat vehicles are expected to weigh between eight and 17 tons and to be built of advanced composite materials, including metals other than steel or aluminum. This approach to combat vehicle construction offers an opportunity to incorporate smart material and adaptive structure technology in a ground vehicle. Aircraft and naval vessels have already incorporated several aspects of this technology; however, technology used for ground vehicles must be highly robust and relatively inexpensive as compared to these other applications. By cleverly designing the hull, suspension, powertrain, crew compartment, and mission-specific equipment with smart materials and active structures in mind, it may be possible to achieve the objectives listed above. Sources of vibration are expected to include the suspension, powertrain, machine guns, wheels, and tracks. Structural and mechanical status reported by smart structures would include play in joints, rigidity, wear, fatigue, corrosion, change in strength/stiffness, temperature, vibration, stress, and strain. Sources of damage could include excessive loading on the structure; incoming ordnance such as artillery fragments, rifle or machine gun bullets, and land mines; fatigue; and corrosion caused by fuels and lubricants, toxic chemicals, salt, and humidity. Monitoring and control could be accomplished by the use of fiber-optic sensors imbedded in the composite structures, strain gauges, piezo-electric devices, shape-memory alloys, electro-rheological fluids, mass-tuned dampers, and electro-strictive devices, along with appropriate sensing and control algorithms.

Phase I: Offeror will present theory and experimental verification of principle. Offeror will clearly show application to a light combat vehicle environment. It is highly preferable that the offeror have brassboard or better hardware or working control algorithm that is readily adaptable for this utilization.

Phase II: Offeror will develop sensor and/or actuator hardware or control software to be used in a government demonstration of related technologies, integrated on a testbed vehicle. The purpose is to establish a benchmark state of the art for smart materials and adaptive structures in advanced composite, light combat vehicles.

ARPA 93-070 TITLE: Parametric Approach to Concept Exploration in Distributed Simulation

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Propose a software template for describing weapons systems in distributed simulation. The template should be sufficiently robust that a designer can adjust design parameters and performance characteristics to either represent existing systems or to perform sensitivity analyses on hypothetical future systems.

DESCRIPTION: Distributed simulation for training and development has evolved to the degree that new weapons system concepts are routinely simulated and evaluated on the virtual battlefield. However, the software architecture, while object-oriented, does not permit new system descriptions to be entered rapidly or easily. Given that many different complex systems can be broken into common logical groupings, e.g., propulsion source, control mechanism, weapon, sensors, etc., it seems logical to attempt to create a software template that can be modified to reflect the performance characteristics of any particular weapon system. This template could then be used to quickly explore the worth of new weapons concepts by entering the unique characteristics of the new system and then participating in distributed simulation exercises from a computer generated forces workstation. Sensitivity analyses could be rapidly conducted by evaluating different versions of

the same system in common scenarios.

Phase I: Develop an object-oriented software template and demonstrate that it can be used to simulate an existing weapons system, the M1A1 tank, and a variation, the M1A2 tank, in a distributed simulation exercise performed from a computer-generated forces workstation.

Phase II: Enhance the flexibility of the software template to accommodate a wider variety of weapons platforms and demonstrate that it can be used to simulate both land vehicles and aircraft in a distributed simulation exercise by participating from a computer-generated forces workstation.

ARPA 93-071 TITLE: Innovative Approaches to Linking Wargames

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Propose methods for linking existing military wargame simulations and the evolving man-in-the-loop distributed simulation capability based on SIMNET (SIMulation NETworking), thereby permitting exchange of data and interoperability.

DESCRIPTION: Distributed simulation for training and development has evolved to the degree that new weapons system concepts are routinely simulated and evaluated on the virtual battlefield. This man-in-the-loop capability injects the human element into the simulation and permits a more realistic assessment of the simulation results. However, because this approach to simulation takes place in real time, it is difficult to generate data in sufficient amounts to permit statistical inference about the battlefield effects of a new system or a change in tactics - that is, it is both too time consuming and too costly. To overcome this obstacle, many analysts use wargaming models that can run faster than real time to generate the data required, or they use computer-generated forces within distributed simulation to reduce the cost of manpower. The ability to combine the strengths of distributed simulation with those of analytical wargames through interoperability would create significant opportunity for improved effectiveness analysis at reduced cost.

Phase I: Develop an approach to linking wargames with distributed interactive simulations in a manner that permits seamless transfer of information and interoperability.

Phase II: Implement the approach developed in Phase I and demonstrate the ability to pass information between an existing wargame and a SIMNET-like exercise at an isolated simulation node.

ARPA 93-072 TITLE: High-Speed Electrodes for High-Density Optical Guided Wave Devices

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop high-speed electrode structures suitable for Electro-Optical (EO) devices on guided wave substrates which have high packing density and cause minimal degradation to device performance.

DESCRIPTION: High-speed, linear guided EO devices have been demonstrated using traveling wave electrode structures operating in the 10-25 GHz range using EO materials such as LiNb03. However, these devices generally consist of only one or a small number of devices per substrate. Before it will be possible to increase the packing density, issues such as electrical and optical isolation, as well as interconnects, must be considered. This may include the development of new optical structures in support of improved device electrodes.

Phase I: Design and develop optical and electrode structures for multiple-element devices that optimize performance and isolation at frequencies in the range of 1-30 GHz. Determine performance limitations and trade-offs. Perform a device demonstration for design verification.

Phase II: Develop and demonstrate high-density device designs for specialized EO components. Optimize designs for performance trade-offs and comparisons.

ARPA 93-073 TITLE: Multisensor Inspection for Microelectronics

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop techniques for sensor fusion between multiple inspection methods for use with s bminiature

electronic assemblies.

DESCRIPTION: A number of inspection techniques exist for inspecting electronic assemblies such as printed wiring boards and multi-chip modules. These techniques include x-ray, infrared, ultrasonic, and three-dimensional x-ray. Often, there is a trade-off between equipment sensitivity and reliability of finding defects: higher sensitivities find more defects but cause more false alarms. A system architecture and algorithmic approach is needed that will fuse image data from multiple inspection methods and, in essence, will increase the signal-to-noise ratio in the data. Such a technique would increase the probability of finding defects, reduce the incidence of false alarms, and possibly allow for discrimination between various defect types. Real-time image processing, neural networks, fuzzy logic, and rule-based systems, or a combination of these, should be considered.

Phase I: Requires concept exploration, review of current literature, feasibility study, and development of proposed system architecture/algorithms. Development of a System Concept Document (SCD), which must include a consideration of necessary hardware, multi-system inspection data fusion techniques, programming strategy, and applicable statistical analysis.

Phase II: Requires preparation of detailed design drawings, collection of data from proposed individual inspection systems, development of pseudo-code to implement algorithms, and assembly of a prototype system. Prototype design will be verified by inspecting example electronic assemblies.

Phase III: A commercial "factory-hardened" system would be designed and manufactured with potentially very broad applications in electronics manufacturing for aerospace, communications, and weapons, as well as numerous consumer products.

ARPA 93-074 TITLE: Residue Number-Based Fast Fourier Transformers (FFTs)

CATEGORY: 6.1 Basic Research

OBJECTIVE: Establish the requirements for Residue Number Systems (RNSs) arithmetic with the ultimate goal of implementing the FFT algorithm in hardware in Phase II.

DESCRIPTION: FFTs are used extensively in radar processing. FFTs implemented with floating-point arithmetic yield the best computational accuracy at the expense of operating speed; whereas fixed-point arithmetic implementations provide for higher processing rates, but with a loss in accuracy. RNSs which utilize parallel processing paths could yield FFT implementations with advantages in speed and accuracy. However, in order to realize the advantages of the RNSs, advancements need to be achieved in the hardware computation of residue-based arithmetic operations, particularly multiplication. RNS-based techniques that obey the cyclic convolution property, such as number theoretic transforms, should be considered in development of the RNS hardware. Further, the designs should be developed for state-of-the-art processor technologies, such as transputers and digital signal-processor chips. Development of special-purpose integrated circuit chips, for example, ASIC, should only be considered if shown to be cost effective.

Phase I: Requirements for RNS arithmetic operations must be established. The FFT algorithm to be implemented shall be considered when developing these requirements. Concepts and preliminary designs will be developed. As appropriate, designs will be analyzed to compute expected performance improvements.

Phase II: The designs developed under Phase I will be completed, implemented, and tested. A prototype FFT, utilizing the improved RNS arithmetic operations, will be fabricated and evaluated. The evaluation should determine speed and accuracy for comparison to current FFT processors.

ARPA 93-075 TITLE: Parallel Infrared (IR) Magneto Mapper for Semiconductor Material

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Demonstrate simultaneous measurement of IR detector material properties over a wafer or film area using Faraday rotation.

DESCRIPTION: Faraday rotation has been demonstrated as a non-contact testing technique for characterizing the electronic properties of semiconductor material to improve the yields of IR detectors. It is a replacement for the Hall technique which requires contacts on the sample and is incapable of high resolution. Present Faraday rotation mapping technology requires

serial sampling of the material area. It is desirable to make Faraday rotation measurements simultaneously over the wafer in order to rapidly screen material to be used in detector design.

Phase I: Identify approaches for parallel measurement of Faraday rotation in IR detector material and develop a magneto-optical mapper design. Perform laboratory demonstrations to prove the feasibility of the design.

Phase II: Construct and test a proof-of-principle demonstrator.

ARPA 93-076 TITLE: Optical to Electrical Power Conversion Unit

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop a reliable and efficient laser to electrical power conversion unit to power telemetry during the ground testing of missiles in strong electromagnetic environments.

DESCRIPTION: Currently, batteries are used to power missiles and missile telemetry during electromagnetic effects testing of these missiles. The batteries used have to be replaced often during testing, a procedure which requires the missile to be disassembled, batteries replaced, and the missile reassembled. This procedure is time consuming and disturbs the test environment, causing errors in the test result. This power cannot be delivered to the missile by wires because the connecting wires would couple the electromagnetic radiation into the missile, disrupting the electromagnetic profile of the missile under test. A solution to this power delivery problem is to send laser power via a nonconductive fiber optic into a module located inside the missile. The module will contain photovoltaic cells which will convert the laser power into electricity. This approach is challenging because significant powers, 28 volts dc and 0.5 amps, are required within the compact space of a two inch by two inch cylinder. A second requirement is 5 volts and 0.5 amps within a one inch by one inch cylinder. This technology will ease electromagnetic disturbance during testing of missiles and missile systems and lead to missiles hardened against electromagnetic interference.

Phase I: Design and build two prototype power conversion modules that demonstrate the capability of producing the 5 volts dc at 0.5 amps and the 28 volts dc at 0.5 amps within the compact space requirements. Assume the optical input to be gallium arsenide diode laser power at a wavelength of 810 nm delivered via a 400 μm glass fiber optic. Phase II: Refine the designs of Phase I and deliver five each of the 2.5 watt and the 14 watt modules. These units must supply power regulated to within 0.1% of the nominal voltage. These units should be optimized to yield a maximum power conversion efficiency.

ARPA 93-077 TITLE: Payout Dynamics Experimental Investigation

CATEGORY: 6.1 Basic Research

OBJECTIVE: Advance high-speed payout reliability technology. Develop test matrices, test hardware, and data reduction techniques.

DESCRIPTION: Fiber-optic cables are now providing communication links for many tethered vehicle and weapon systems. The demands for increased range, speed, environmental fortitude, and shelf life continue to increase. Thus, added emphasis has been placed on defining the communication link's reliability. The probability of reliability and the design limitations of fiber-optic dispensers are not easily predicted. The dynamics of fiber payout have not been adequately defined. Laboratory data has shown that non-steady state conditions occur during fiber payout at high speeds. Several parameters contribute to the phenomena observed during payout; however, the acceptable range of the parameters or the limits of a dispenser design is unknown. In order to learn the conditions under which reliability degrades, tests must be conducted that explore the range boundaries of payout parameters. A test matrix must be devised that will test system limitations, hardware must be assembled that can collect the proper data, and the tests must be conducted under stringently monitored conditions.

Phase I: Review Government developed optical-fiber payout test matrices. Determine or develop a test matrix that incorporates parameters as necessary. Develop a test plan and procedure. Identify test data collection and data reduction equipment. Conduct feasibility test to verify test setup. NOTE: Well-equipped, high-speed payout facilities are available at U.S. Army Missile Command (MICOM), Redstone Arsenal, AL.

Phase II: Design and fabricate fiber-optic dispensers for design of experiments testing. Define test values for bobbin diameter, length, and taper angle; payout velocity; adhesive strength; fiber type and diameter; and temperature, at a minimum. Conduct payout testing, data collection, and data reduction for determination of the influence rating of

parameters. Based on test-data interpretation, predict the probability of reliability curves for optical-fiber payout.

ARPA 93-078 TITLE: Compact Acoustic Plane Wave Generator

CATEGORY: 6.2 Exploratory Development.

OBJECTIVE: Design and develop a small-scale acoustic plane wave generator for acoustic frequencies between 60 Hz and five KHz.

DESCRIPTION: A device is required for the generation of planar acoustic waves over a symmetrically dimensioned volume of approximately one cubic meter in the frequency range 60 Hz to five KHz. Frequency response over the operational frequency band should be reasonably flat. The generation system should be designed to occupy an enclosure suitable for location in a modest size laboratory. The system is to be fed from one end of the enclosure with 16-bit digital acoustic data from which the analog acoustic signals must be produced and transmitted within the enclosure. Test article access ports are required at the opposite end of the enclosure. An acoustic probe system within the enclosure is required for test and calibration of the generation system.

Phase I: Design, development, and verification by means of a digital simulation.

Phase II: Fabrication and demonstration of the generation system.

ARPA 93-079 TITLE: Thrust Vector Control (TVC) System for Low-Cost Expendable Turbojet Engines

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a flight-vehicle control system for a tactical missile that solely utilizes thrust vector control of a turbojet sustainer propulsion system.

DESCRIPTION: In the design of future missile systems, an increased emphasis has been placed on reducing the radar cross-section of the airframe. A significant contributor to the overall radar signature of a tactical missile are the control surfaces. Elimination of control surfaces should, in general, greatly reduce the radar cross-section of the missile. One means of eliminating the control surfaces on a turbojet powered tactical missile is to employ a TVC system that utilizes the turbojet exhaust to provide flight vehicle control authority. Consequently, the development of such a turbojet sustainer-based TVC system for a tactical missile is necessary. The TVC system to be developed should be designed for integration and operation with an existing, small, low-cost, expendable turbojet engine. The system should be consistent with incorporation in a tactical missile and emphasis placed on minimizing cost, weight, and parts count. An integrated system should function simultaneously as both the sustainer propulsion system and the flight vehicle control system. An integrated control system should provide for control of both the thrust magnitude (engine fuel control) and the thrust direction (TVC). A fluidics-based control system should be evaluated. The integrated sustainer/TVC system should provide pitch, roll, yaw, and velocity control at magnitudes and rates that are consistent with those required by a subsonic tactical missile.

Phase I: Design, fabrication, and delivery of a heavy-wall TVC system for integration with a Government furnished small turbojet engine. The following engines are available: Sunstrand TJ-50; Williams WJ119, P8910, P9005; Teledyne 305-10; Allison 120; and Technical Directions four inch and seven inch.

Phase II: Design, development, and delivery of a flight-weight integrated TVC system. The system shall be integrated with a turbojet propulsion system and delivered to the Government for experimental evaluation.

ARPA 93-080 TITLE: High-Strength Bend-Insensitive Polarization Maintaining (PM) Fiber Development for Inertial Sensor Applications

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Advance the development and fabrication of PM fibers that are stronger and insensitive to bend losses, and thus are highly reliable inertial sensors.

DESCRIPTION: PM optical fibers that are currently being produced show a degraded extinction ratio due to bend losses.

In inertial sensors this means that sensors cannot be packaged as compactly as is theoretically possible. In addition, the PM fibers are not very strong and, therefore, tend to break during handling or fail over time. PM fibers used for inertial sensor applications should be more reliable and suitable for harsh environments.

Phase I: Develop an approach for fabricating PM fibers with greater strength and less bend sensitivity, while maintaining current PM fiber performance standards.

Phase II: Fabricate prototype optical fiber and evaluate the performance characteristics of the fiber. Provide a detailed set of procedures, including a description of the equipment and facilities necessary to produce the high-strength, bend-insensitive optical fiber in large quantities.

ARPA 93-081 TITLE: Micro-Lasers for Infrared Scene Projection

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop micro-laser technologies for future application to Infrared (IR) scene projection in Hardware-in-the-Loop (HWIL) simulations.

DESCRIPTION: Several weapon systems are currently under development throughout all branches of DoD which utilize multiple IR wavebands for target detection and intercept. Both two-dimensional focal plane arrays and linear arrays of detectors with less than 30 total detectors are used in these systems. In the scanning systems, optical components scan the total field of view and the detector elements are read out at extremely high rates. Conventional IR projection techniques cannot support the modulation of the IR signal outputs at the rate required for accurate HWIL tests of these systems. These performance limitations have forced the exclusion of the IR detectors from HWIL simulations. HWIL simulations are necessary to adequately assess weapon-system performance, therefore, innovative and fast IR projection techniques are needed to overcome these limitations. Currently, two-dimensional micro-lasers are being researched for application in the visible to near-IR region. Accordingly, if extensions can be made into the longer wavelengths, an IR projector capable of supporting HWIL tests could be developed.

Phase I: A conceptual design and laboratory demonstration of two-dimensional micro-laser devices operational at the MWIR or LWIR wavelengths.

Phase II: Extension and upgrade of this technology for use in HWIL simulations of IR missile systems.

ARPA 93-082 TITLE: Automated Bobbin-Baselayer Inspection System

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a nondestructive automated system (methodology, software, and equipment) capable of characterizing the geometry of the baselayer and wound-fiber layers and that can be used as an evaluation tool for these parameters.

DESCRIPTION: Fiber-Optic Guided Vehicle (FOG-V) dispensers designed for high-speed payout consist of a bobbin, which is precision wound with the optical-fiber data link. The baselayer is on the surface of the bobbin and forms the winding guide for the first layer of optical fiber. Anomalies, such as uneven groove spacing, bicuspid grooves, uneven groove depth, etc., can occur in fabrication of the baselayer. At present, there are no dedicated tools that can be used to evaluate the integrity of the baselayer or to identify and characterize significant flaws in the baselayer. The required system resolution is +/- 0.5 micrometer (+/- 0.00002 inch) in the radial direction and the ability to measure distance between the baselayer centers within +/- 20 micrometers from the flange end and within +/- 2 micrometers between adjacent baselayer grooves. The developed system must be capable of recording the change in radius of the fiber-optic dispenser surface along the bobbin axis and at points around the bobbin circumference. An automated system is needed so that no operator intervention is required after setup. The tool should be flexible enough for use in correlation of winding flaws to baselayer anomalies, and to determine acceptance criteria for the baselayer. An existing system which resides at U.S. Army Missile Command (MICOM), but does not have the resolution or speed necessary to meet the above requirements, can be made available for modification.

Phase I: Evaluate the MICOM GFE Slump Measuring System for use as an automated inspection system for the bobbin/baselayer. Demonstrate a breadboard automated baselayer measurement system by inspecting at least two bobbins (one aluminum IOE FOG-M design and one fiber glass filament wound composite) before and after baselayer application and winding.

Phase II: Complete development of the system. Perform studies to correlate baselayer anomalies to fiber winding flaws. Determine acceptance criteria for baselayers. Perform acceptance measurements for 20 bobbin baselayers.

ARPA 93-083 TITLE: Models for the Growth and Processing of Infrared (IR) Materials

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop models for simulation of infrared material growth and detector manufacturing.

DESCRIPTION: The growth and processing of IR material and devices require extensive knowledge of material parameters over a wide range of processing conditions. This is especially important in a flexible manufacturing environment, where equipment and processes must adapt rapidly and precisely to material with varying characteristics and devices over a wide range of operating conditions. Models, with the capability to simulate major aspects of the IR manufacturing process including the equipment environment, are necessary to establish the robust manufacturing processes necessary for IR material and detectors. Examples of the models required include a description of the growth of bulk cadmium telluride crystals, the generation and propagation of defects in bulk and epitaxial layers, and models of the detector surface properties, doping and junction formation mechanisms. These models must be experimentally verified and applied to process-control systems for IR material and device manufacturing.

Phase I: A specific element of IR material growth or detector manufacturing must be selected and a strategy developed to establish a simulation, taking advantage of prior theoretical and experimental work. The physical mechanisms controlling the process must be investigated and analytical expressions and algorithms developed to predict material properties under a wide range of operating conditions. A strategy must also be developed to experimentally validate the model. Computer code will then be written to describe a representative segment of the model, and the model exercised to determine the agreement with published data. The interface of the model with processing equipment must also be considered and a strategy developed with equipment vendors and IR manufacturers to utilize the model in manufacturing.

Phase II: The complete analytical model of the IR process selected must be coded, exercised and compared with experimental data. Graphical simulations of the manufacturing process should be utilized wherever possible. The simulation must include the capabilities to predict characteristics over large areas wafers, to provide insight into techniques to reduce defects in IR materials and devices, and to produce high-density, multi-layer devices. The model developed must be integrated with equipment for the processing and characterization of IR material and devices.

ARPA 93-084 TITLE: Process Control Technology for Infrared (IR) Materials Growth and Device Fabrication

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop sensors to monitor IR material and detector characteristics during manufacturing. The sensors are to be integrated into a process control architecture and used in IR material and device manufacturing.

DESCRIPTION: Precise control of processes for the growth of IR material and the fabrication of IR detectors is essential to achieve high yields and low costs in the relatively low-volume arena of semiconductor technology; an area which is critical to defense systems. A major factor in development of a process control technology for IR material and devices is the establishment of a suite of sensors which can be integrated into manufacturing equipment and used as real-time process monitors. Examples of IR manufacturing processes which necessitate these sensors include: bulk and epitaxial growth of substrates and IR sensitive layers, surface processing, junction formation, etching, and doping control. The sensors must characterize the optical, electrical, or structural properties of the material during processing, without disturbing the IR material or the manufacturing process. Several of the characterization techniques used in the laboratory to evaluate IR materials are potentially applicable to this project.

Phase I: A sensor or suite of sensors must be selected to monitor a particular aspect of the IR material growth or device processing. A strategy for measuring critical process parameters must be developed, including the establishment of a relationship between the sensor output and a particular aspect of the IR manufacturing process. Measurements must be made in the laboratory to verify the accuracy and repeatability of the sensor characteristic. A specification for the sensor must be developed and a plan established for interfacing the sensor into a control architecture to be used in IR material growth or detector manufacturing equipment.

Phase II: The sensor(s) must be integrated into a process control system and demonstrated on a specific aspect of

the IR manufacturing process. The impact of the process control system on the yield of the manufacturing process must be established experimentally. An interface with an IR material growth or detector manufacturer is also necessary for transition of the control technology into the manufacturing environment.

ARPA 93-085 TITLE: Processes and Equipment for Advanced Devices

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop enhanced semiconductor manufacturing processes and equipment which enable abrupt, retrograde and shallow junction formation with low thermal budget.

DESCRIPTION: The fabrication of Ultra-Large-Scale Integrated Circuits (ULSIC) has relied upon conventional ion implantation and hot-wall furnace annealing technology for the formation of device junctions and isolation wells. As device geometries and operating voltages decrease, innovative processes and manufacturing equipment will be needed for the formation of ultra-shallow (<50 nm) junctions and deep, abrupt or retrograde wells. The resulting junctions must exhibit abrupt impurity profiles, low sheet resistance, and no substrate damage. Retrograde profiles must demonstrate at least an order of magnitude increase in concentration from the surface to the junction over a distance of several hundred nanometers. All of these processes must be implemented with low thermal budget to minimize dopant redistribution. This program will develop alternatives to conventional ion implantation, novel processes for dopant activation and associated processes to achieve advanced junctions profiles. Candidate technologies of interest include, but are not limited to: adsorption/annealing with Rapid Thermal Processing (RTP), low-energy dopant deposition, plasma dopant incorporation, gas immersion laser doping, low-energy implantation for shallow junctions and high-energy implantation for deep retrograde profiles and associated equipment for process control. Proposed processes and equipment must be fully compatible with cluster tool environments, exhibit the potential for manufacturing throughput and must be compatible with conventional integrated circuit device fabrication sequences.

Phase I: Demonstrate initial feasibility of the proposed process or equipment, provide initial yield and manufacturing costs estimates and develop a commercialization plan.

Phase II: Demonstrate a prototype process (or subprocess) in a manufacturing capable tool using the results of Phase I.

ARPA 93-086 TITLE: Simulation Tools for Plasma Reactor Synthesis

CATEGORY: 6.1 Basic Research

OBJECTIVE: Develop a set of simulation tools for the synthesis of plasma reactors for the semiconductor manufacturing industry.

DESCRIPTION: Plasma processing has become an enabling technology for manufacturing integrated circuits with decreasing feature sizes and aggressive topologies. These reactors operate over a wide variety of pressures and with a broad range of reaction constituents to achieve the selected manufacturing result. To date, these process tools have been designed through successive trial and iteration rather than by a model-based approach. As semiconductor manufacturing drives to increase process uniformity and reduce wafer-level defects a new method of designing plasma tools will be needed. This two-phase program addresses the development and implementation of model-based simulators for the synthesis of reactor chambers, associated gas distribution systems, and process sensors for plasma reactors used in the semiconductor manufacturing industry. The resulting models must accurately describe the process and must be computationally efficient.

Phase I: Identify and develop initial models which address, but are not limited to, process kinetics, gas flow dynamics, particle nucleation, plasma induced device damage, surface charging, and particle transport.

Phase II: Refine and validate these models for a candidate manufacturing process used in the semiconductor industry and demonstrate the use of these models to synthesize a new or improve an existing plasma reactor or subsystem.

ARPA 93-087 TITLE: Chemical Vapor Deposition (CVD) of Next Generation High-Density Interconnects

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop CVD processes and equipment which interface with cluster semiconductor manufacturing tools for sub-0.25 micron geometries.

DESCRIPTION: Advanced CVD of dielectrics and metals are key to achieving the device performance and integration levels of the next decade. As interconnect dimensions are reduced, clock distribution and cross-talk become limiting factors in high-speed, high-integration designs. A variety of device interconnect strategies have been proposed in literature addressing these effects. This program will identify and develop innovative CVD processes and equipment for high-speed, high-integration circuits. Processes of interest include CVD copper for plug and interconnect, refractory barriers, selective metal deposition, low dielectric constant films (< 1.5), planarized films, low-temperature CVD deposited films (< 300C), low defect-density films (0.004 defects per square centimeter), and improved uniformity (3%). The resulting processes will be demonstrated in a cluster tool for implementation into a semiconductor manufacturing flow.

Phase I: The initial program phase will identify CVD process improvements and propose a cluster tool implementation approach. The recommended approach will be evaluated for projected performance limitations, process and tool integration, throughput limitations and impact on device yield.

Phase II: The final program phase will optimize the process improvement and result in the demonstration in a prototype cluster tool for integration in a manufacturing environment.

ARPA 93-088 TITLE: Lenses and Mirror Technology for X-ray Lithography

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Develop technology related to optical elements for use in proximity (one nm) or soft x-ray (13 nm) projection lithography. Technologies of interest include fabrication techniques, materials, metrology, characterization, and application of these optical elements.

DESCRIPTION: Current approaches to x-ray lithography include proximity and projection methods, using wavelengths in the range of one and 13 nanometers, respectively. The availability of a wider variety of appropriate optical elements will provide the lithography tool designer with flexibility to optimize tool design. In recent years, several approaches have demonstrated the capability to further control x-ray beams and enhance the performance of x-ray lithography tools. Opportunities for improvement in performance of these optical elements exist in the areas of sources, materials and fabrication methods, controls used during fabrication, alignment and positioning in the optical path, and characterization of the finished product. Finally, the success of the efforts will be indicated by the installation and characterization under testbed conditions.

Phase I: Identify an approach which offers improvements such as cited above, evaluate the technology base against needs, and detail a plan to develop and demonstrate a prototype.

Phase II: Build and characterize a prototype and detail a plan to integrate into a lithography tool.

ARPA 93-089 TITLE: Stress-Free Membranes for Submicron Stencil Mask

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Explore the theory and materials systems that would facilitate the fabrication of stencil masks for 0.18 micron and smaller design-rule lithography.

DESCRIPTION: Both ion-beam and electron-beam projection lithography can be implemented with the use of stencil masks. These lithography schemes are being considered as alternatives for optical or x-ray lithography when the design-rule scaling in semiconductor Integrated Circuits (ICs) reaches dimensions of 0.18 micron or smaller. At that time, it is also expected that an ICs chip field size will be 20 by 20 mm or greater. Technology is being sought that can be used to fabricate stencil masks appropriate to these lithography goals. Initial effort should concentrate on identifying the appropriate stencil mask material or materials and suitable fabrication technology. The theoretical effort must address stress issues,

trade-offs between one-to-one masks and reduction masks, temperature limits, and other pertinent problems.

Phase I: Select the material(s) and processing techniques that result in the most promising stencil masks. Provide theoretical justification for the choices and tabulate pertinent theoretically derived performance characteristics.

Phase II: Fabricate proof-of-concept, high-density stencil masks for 200mm wafers. Establish experimental performance characteristics and cost of fabrication for such masks.

ARPA 93-090 TITLE: Photoconductive Switch for Reconfigurable Antenna

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop high-performance photoconductive switches for interconnecting antenna segments so that the antenna can be optimally shaped for a specific function.

DESCRIPTION: An optimally shaped antenna is desireable for specific functions. An optically controlled reconfigurable antenna can serve to combine many different antennas into one. Photoconductive switches actuated by photons provide connectivity with desireable electrical characteristics. The switches must be integrable into the antenna pattern. The choice of material system, and the device design and processing are critical steps leading to the successful development of this technology.

Phase I: Propose and verify optimal device design. Demonstrate discrete devices with desired characteristics. Outline approach to realize an integrated antenna with photoconductive switches.

Phase II: The performance of the proposed antenna system will be simulated. The antenna system will be fabricated and tested in various configurations. Optimal performance criteria will be delineated while minimizing optical control power. Reiterate process to generate field testable components. Demonstrate and deliver to system applications companies for incorporation.

ARPA 93-091 TITLE: Simulation, Modeling and Computer Aided Design Tools for Optoelectronics Components

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Design and develop new optoelectronic devices and integrated circuits through optimization of computer simulation and modeling of semiconductor materials and device structures for applications in high-speed signal processing and computation.

DESCRIPTION: Combining optical and electron devices into optoelectronic systems has emerged as the method of choice for enhancing the speed performance of signal processing, computation, and telecommunications. Significant advantages in speed, power, weight, and size appear if monolithic integration is achieved between the electron and optic devices on a single semiconductor substrate. Different materials properties for the separate electronic and optical devices makes it difficult to design and optimize the performance of the devices and circuits. Computer simulation methods have emerged as a critical element in the process of designing electronic devices and circuits. Numerical simulations need to be developed for optical devices such as lasers, modulators, wave guides, and detectors for design and optimization of optoelectronic integrated circuits. Such simulation and modeling will greatly reduce the development costs and assist designers in optimizing circuit designs.

Phase I: Numerical simulation methodologies will be chosen and developed for computer modeling of integrated semiconductor optoelectronic devices and circuits. Physics and circuit performance should be addressed and optimized with respect to threshold current, output power, efficiency, and modulation frequency.

Phase II: The procedures developed in Phase I will be extended to consideration of devices in which small dimensions leading to quantum effects are dominant. These results will be validated by coordination with experimental programs at commercial, university, and government laboratories. Designs will be proposed that lead to the highest speed circuits of interest to telecommunications, computation and signal processing.

ARPA 93-092 TITLE: Applications Demonstration Utilizing Optical Computing

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Demonstrate specific applications using optical computing.

DESCRIPTION: Optical computing is capable of massively parallel processing and may generate a new computing paradigm. At this point, the clear advantages intrinsic to optical computing have not been isolated. This solicitation seeks to clarify the potential usefulness of this new technology by demonstrating applications that delineate the advantages of optical over conventional computing.

Phase I: Select and nominate applications that require unique functionalities provided by optical computing. Discuss the layout and component requirements for this demonstration. Delineate the advantage accrued by using optical computing technology. Compare, in detail, performance differences between electronic and photonics as applied to the specific application through simulation.

Phase II: Fabricate and assemble the proposed optical computing system. Generate control hardware and software, input/output requirements to fully demonstrate the selected applications. Analyze the advantages and the disadvantages of optical computing from the data accumulated while running the experimental application. Modify the system to obtain optimal results and compare with the results using conventional approaches.

ARPA 93-093 TITLE: Lightweight, Hand-Held Gamma Ray Detector with Isotope Identification Readout

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Investigate and develop the hardware and software for a small gamma ray detector to identify the isotope(s) emitting gamma rays.

DESCRIPTION: Nuclear nonproliferation has attracted a considerable amount of world-wide interest. In order to monitor the suspected movement of radioactive materials from one location to another, radiation detectors with increased versatility are needed. Present detectors are large and have sufficient resolution to display gamma peaks, but do not include an automated system for isotope identification. The detector envisioned would be about the size of a hand-held, videocassette recorder remote control and have a display identifying the radioactive isotope(s) emitting the gamma rays. This beginning system should possess a resolution of less than five percent (5%) and a count time of less than one minute. At the end of the count time, the display should provide a readout identifying the isotope(s) of interest.

Phase I: Investigate, identify, develop, and select the materials and software needed to produce a lightweight, hand-held gamma ray detector. Hardware and software capable of using the information gathered by the detector should be evaluated for ruggedness, size, weight, and speed in identifying the isotope of interest.

Phase II: Develop and demonstrate a prototype gamma ray detector.

ARPA 93-094 TITLE: Gamma Ray Lens Feasibility Study

CATEGORY: 6.1 Basic Research

OBJECTIVE: Provide a feasibility study discussing the development and potential applications of a gamma ray lens.

DESCRIPTION: A number of years ago, the possibility of using a neutron lens for neutron activation analysis seemed remote; however, this is no longer the case. Smooth, hollow-glass capillaries are now used to guide neutrons and x-rays by way of multiple reflections along the capillaries' inner walls. The June 4, 1992 publication of *"Nature"* described a neutron lens developed in Russia. As an extension to this concept of focusing particles or high frequencies of the electromagnetic spectrum, a feasibility study should be conducted that explores the practicality and usefulness of focusing gamma rays. This study should investigate the feasibility of materials, their size and shape, and the cost of producing such a lens. Possible applications of this lens should be noted as well. One possible use of a gamma ray lens device would be to focus photons on cancerous tissue directly. Other applications beyond medicine should also be considered.

Phase I: Perform analysis of the feasibility of focusing gamma rays using a mechanical lens device.

Phase II: Investigate materials, size and shape, and cost of a mechanical device needed to focus gamma rays on a

sample material.

ARPA 93-095 TITLE: Lightweight, Hand-Held Chemical Detector with Chemical Identification Readout

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Investigate and develop the hardware and software for a small chemical detector to identify the effluent of interest.

DESCRIPTION: Nonproliferation of weapons of mass destruction has attracted a considerable amount of world-wide interest. In order to monitor the suspected production of chemical weapons, chemical detectors with increased versatility are needed. Present detectors do not include an automated system for chemical identification. The detector envisioned would be about the size of a hand-held, videocassette recorder remote control and have a display identifying the number of chemical effluents in the area. The display should provide a readout identifying the chemical effluents being detected. Detection and identification time should be minimal in order to prompt, if necessary, timely safety measures. Phase I: Investigate, identify, develop, and select the materials and software needed to produce a lightweight, hand-held chemical effluent detector. Hardware and software capable of using the information gathered by the detector should be evaluated for ruggedness, size, weight, and speed in identifying the effluent of interest.

Phase II: Develop and demonstrate a lightweight, hand-held prototype chemical effluent detector.

ARPA 93-096 TITLE: Optimization of Real-Time Communications for a Global Nuclear Proliferation Monitoring System

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a low-cost, real-time communications system for global monitoring of nuclear proliferation.

DESCRIPTION: ARPA is interested in novel concepts for real-time communications systems to support global monitoring of nuclear proliferation. The communications concept must be optimized to support rapid, reliable data exchange at the lowest possible cost. Data will include parametric data, seismic wave-form data, nonseismic data (e.g., gamma ray spectra), data requests, system maintenance data, e-mail, etc. Locations to be interconnected include developed and underdeveloped countries, and remote sites with and without existing communications facilities. Data compression technology, shared networks, and space-based cellular communications are among potential areas to be investigated.

Phase I: Identify approaches and/or concepts, and design a plan for demonstrating the effectiveness of a communications system based on these approaches/concepts.

Phase II: Conduct an experimental program to test novel elements of the communications system, and demonstrate the feasibility of the system.

ARPA 93-097 TITLE: Assessment of Techniques for Nuclear Testing that Evade Detection, and Development of Monitoring Approaches to Counter Such Evasion Attempts

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop novel techniques that might be used by a nuclear proliferator to evade detection of nuclear weapons tests. Investigate monitoring methods that the United States might use to counter such evasion attempts.

DESCRIPTION: Identify novel methods that a potential nuclear proliferator might use to evade detection of nuclear weapons tests, e.g., conducting tests in the ocean or atmosphere. Conduct theoretical research to quantify the optical, acoustic and/or seismological signatures that would result from such evasion methods. Investigate methods that could be used by the U.S. or the global monitoring community to counter such evasion attempts.

Phase I: Describe the problem background and provide a conceptual, mathematical description of a novel method or methods that might be used to evade detection of a clandestine nuclear test. Design a plan for evaluating and/or conducting a scaled demonstration of the method(s).

Phase II: Based on the results of Phase I, conduct a full investigation of the evasion scenario(s), and develop methods that could be used by the U.S. or global monitoring community to counter such evasion attempts.

ARPA 93-098 TITLE: Laboratory and Theoretical Research to Predict the Effect of Decoupling on Various Comprehensive Test Ban Treaty Evasion Schemes

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Conduct scaled laboratory experiments and theoretical research to predict the seismological effects of schemes to evade the detection of nuclear tests under a comprehensive test ban treaty.

DESCRIPTION: ARPA and the Air Force are developing a plan for implementing a global network to monitor nuclear proliferation, as well as to verify compliance with a possible comprehensive test ban treaty. For maximum effectiveness, the network should be designed to insure detection of known evasion scenarios, such as cavity decoupling, or masking a small nuclear test with a large quarry blast. This project is to conduct theoretical research, supplemented by scaled laboratory experiments, to quantitatively assess the seismological effects of such evasion scenarios.

Phase I: Identify approaches to a combined theoretical/laboratory study of treaty evasion scenarios, and conduct preliminary calculations and laboratory tests to demonstrate the techniques that will be used in an expanded research program.

Phase II: Based on the Phase I results, conduct a program of research to quantify, under a range of geologic conditions and test yields, the seismological effects, at both short and long distances, of known evasion methods. Use the research findings to predict the character of seismic signals to be expected at various distances.

ARPA 93-099 TITLE: Photonic Radar Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop new concepts and approaches in integrated radar system technology utilizing photonic elements to achieve significantly greater system performance.

DESCRIPTION: Photonic technologies have the potential to allow much greater radar system performance than can otherwise be achieved with conventional digital or analog signal processing. As a result, systems architectures which exploit advancements in photonic technology to achieve significant radar performance improvements are being sought. The fully integrated system must be capable of detecting very small radar cross-section targets, such as sea-skimming and cruise missiles; providing high-resolution range measurements; and reducing sensitivity to electronic countermeasures.

Phase I: Address concepts for and approaches to the development of photonic radar systems, identify the most suitable approach, and perform sufficient analysis and design to indicate a reasonable probability of success in Phase III for feasibility demonstration.

Phase II: Use the approach defined in Phase I to develop detailed system requirements, build and demonstrate selected critical system elements, and deliver a preliminary radar system technology demonstration design to the Government for evaluation.

Phase III: This phase is anticipated to transition the Phase II products to a specific application via design, resolution of unresolved production and manufacturing issues, and/or demonstration of a photonic radar system or subsystem.

ARPA 93-100 TITLE: Interference Rejection and Angle Estimation Techniques for Antenna Arrays with Uncertain Element Locations

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop effective techniques for beamforming in the presence of interfering signal sources and jammers with antennas whose element locations cannot be precisely controlled.

DESCRIPTION: Modern aircraft radar antennas can be deployed over extended portions of the aircraft surface. Beamforming with such antennas requires precise knowledge of the element locations. Such knowledge may be difficult or impossible to obtain by direct measurement due to flexing of the array. Techniques for adaptive cancellation of interfering signal sources are well-known, but can result in large errors in estimation of the angle of arrival of desired signals. In addition, computational requirements for adaptive processing can become very large if many degrees of freedom are required. This solicitation seeks to explore techniques for beamforming such an array. Algorithms need to be developed that can learn the time-varying locations of the antenna elements, possibly using information present in the clutter and jamming itself. Of particular interest are the quality and robustness of interference rejection, and the angle accuracy. Computational complexity is of concern, but is of secondary importance.

Phase I: A study containing a mathematical examination of alternative algorithms, and analyses resulting in the recommendation of preferred technique(s).

Phase II: A detailed simulation of the performance of the selected beamforming technique for an antenna configuration to be selected jointly by the contractor and ARPA.

ARPA 93-101 TITLE: Electrooptic Materials Development

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop an electrooptic material and associated manufacturing process that maximizes the electrooptic effect and minimizes the electroacoustic effect.

DESCRIPTION: One class of analog fiber-optic communications link utilizes the Mach-Zehnder device. This link consists of a laser light source that sends unmodulated light through a fiber to a Mach-Zehnder on a lithium niobate crystal. The Mach-Zehnder consists of a wave guide for the light on the surface of the crystal. The wave guide passes between two electrodes. A voltage applied to the electrodes will cause the light energy to be amplitude modulated and the modulated light is carried to a detector by another fiber. This link technology has applications in situations requiring a large bandwidth, and where the presence of conducting cables - e.g., coaxial cables - would otherwise cause other undesired effects. This link technology has application over a wide range of frequencies from a few MHz to more than 1,000 MHz. The technology takes advantage of the electrooptic effect in the lithium niobate material. An important problem that is prevalent at low frequencies - below about 200 MHz - is that lithium niobate also exhibits an electroacoustic effect. The application of a periodically varied voltage to the electrodes on the material will launch acoustic vibrations in the bulk of the material. These microscopic vibrations are sufficiently large enough that they alter the electrooptic properties in an undesirable manner. This can be shown by comparing the detailed bandpass characteristics between two links. In certain antenna applications the measurement of interest is called the cancellation ratio, which is the difference in the bandpass characteristics over a specified bandwidth. A desirable number is a ratio of 50 dB or more over bandwidths in excess of 100 kHz, for links operating at frequencies below about 200 MHz. The goal of this work is to identify a material having properties which minimize the electroacoustic effect and maximize the electrooptic effect. It is important that the new material also minimize the loss the light experiences while passing through the Mach-Zehnder pattern on the surface. It is also important that the voltage variation necessary to modulate the light from maximum intensity to extinction be on the order of about one volt.

Phase I: Perform a literature search on materials that have been tested in both electrooptic and electroacoustic applications to identify the most promising materials for testing.

Phase II: Develop techniques to embed light wave guides into the material surface and electrodes on the material's surface. Test the prototype devices for light loss, voltage required to modulate the light, and performance over temperature. Continue to fine tune the materials and techniques to develop a low-cost manufacturing approach.

ARPA 93-102 TITLE: Develop Ground Bounce Jammer Mitigation Techniques for Communication and Radar Systems Implementation

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop algorithms suitable for real-time implementation to suppress this type of interference.

DESCRIPTION: Communication and radar systems in aircraft are potentially vulnerable to jamming from another aircraft

where the strategy is to bounce the jamming signal off the ground. The effect is to cause multipath jamming to come from a broad angular sector instead of a single direction, thereby complicating the usual nulling approaches with phased array antennas. However, the ground bounced multipath signal is a time delayed and doppler shifted replica of the transmitted jammer signal. Approaches to multipath interference in the past have employed either adaptive temporal processing or adaptive sub-band processing. The limitations of one or both of these mitigation techniques include: the fact that they require a large number of degrees-of-freedom to null the interference; their difficulty in dealing with the doppler shift of the ground bounce signal; and in the look-down radar case, a problem in dealing with radar ground clutter. Proposed techniques should specifically address these limitations and should not assume that a clean replica of the jamming signal is available by pointing a beam at the jammer.

Phase I: Perform a literature search on methods to model this phenomena and proposed solutions. Develop techniques which address the above issues and evaluate them. The Phase I deliverable would be a mathematical description of the proposed technique and the preliminary analytical or simulation results.

Phase II: Continue to fine tune promising techniques plus signal processor architectures to implement the recommended approaches. The Phase II deliverable would be an operation count and processor architecture.

ARPA 93-103 TITLE: Lattice Wing Technology for Maneuverable Towed Bodies

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop innovative lattice wing control surface concepts for controlling maneuverable towed bodies.

DESCRIPTION: Modern air vehicles may deploy towed bodies behind them in-flight to house off-platform devices. It is desirable to be able to maneuver these bodies off the longitudinal axis of the host platform. Lattice wing control surfaces appear to offer advantages over conventional wing or fin control surfaces in areas such as aerodynamic force generation, control power requirements, linearity, rigidity, and compact storage. This solicitation seeks to examine the characteristics of lattice control surfaces for this application. This includes cell spacing requirements, airfoil shaping effects, and aerodynamic stability. Of particular interest is the ability to generate large aerodynamic forces with small physical size.

Phase I: The Phase I product will be a study developing concepts for lattice wing control surfaces and describing their characteristics and capabilities.

Phase II: The Phase II product will be a prototype lattice wing controlled body suitable for demonstration either in a wind tunnel or as a full-scale towed model.

ARPA 93-104 TITLE: Photonic Hybrid Devices for Radar and Communications Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop innovative photonic hybrid devices that maximize gain and dynamic range of radar and communication subsystems.

DESCRIPTION: Emerging optical and optoelectronic technologies have the potential to permit much greater radar and communication systems performance than can be performed by conventional digital and analog systems. Increased system capabilities achieved by temporal, spatial, or wavelength multiplexing, coherent detection, optical routing and switching, etc., that result in significantly improved antenna gains, system/device noise figures, etc., are of interest in this solicitation. Proposed devices may be single elements that could be directly substituted in existing or advanced radar and communication systems, such as an optical mixer, or hybrid groups of optoelectronic elements that may replace complete functions, such as an optical corporate-feed subsystem. All proposed elements/modules must be compact, self-contained, and mechanically and thermally stable devices/subsystems that offer enormous advantages over conventional electronic systems.

Phase I: Design and develop optoelectronic concepts that can be physically scaled and implemented in advanced radar and communications subsystems.

Phase II: Demonstrate, test and deliver a practical application of a compact, survivable, and reliable optoelectronic device/subsystem that will significantly enhance radar/communications subsystem performance.

Phase III: These devices/subsystems could make a major contribution in inserting optoelectronics technology into advanced radars and communication systems. Strong possibilities exist that several ARPA/Service programs would consider using these devices/subsystems to support whatever optical signal conditioning or processing technology their particular

program used.

ARPA 93-105 TITLE: Knowledge Query and Manipulation Language (KQML) Interfaces

CATEGORY: 6.3 Advanced Development

OBJECTIVE: Development and distribution of KQML interfaces, to be used in integrated manufacturing and planning domains.

DESCRIPTION: Research has developed and demonstrated the viability of a language that can be used to specify transport of complex information units among applications and information servers. The language serves as a layer or wrapper between transport protocols (such as e mail or sockets) and declarative expressions of information units being transmitted for remote processing. The actual information units can be expressed in a variety of differing formats, such as: formal logic; statements as expressed in such high-level languages as PROLOG, LOOM, and CLASSIC; rules as employed in many expert systems; complex objects as handled in such languages as SMALLTALK, C++, and Ada; datastructures as used in record-based languages; or similar structures as stored in corresponding database systems. KQML names and transports, but does not attempt to understand, the meaning of these units. Since information units are likely to be context dependent, the KQML specifications include: (1) performatives, to drive inference and execution at the remote sites; (2) communications instructions, to define the conventions to be followed in transmitting a response; and (3) named ontologies, to provide for a match of the vocabulary that was used in expressing the information unit. A variety of Application Programming Interfaces (API) will be needed to enable application-oriented programs or expert systems to express their needs using the KQML conventions and to allow other applications or information servers to execute those requests. Some APIs must allow communication between systems using differing representation languages, via an intermediate interchange format. Some of these must satisfy needs as expressed in the F-22 IWSDB, PACT, and DRPI efforts.

Phase I: Deliver a documented, functional prototype of a server interface application. The documentation should specify which of the performatives listed in the KQML document have been implemented. Plans for long-term support and maintenance should be outlined.

Phase II: Complete a set of KQML compliant interfaces using performance information obtained by testing and analysis. The business case should indicate long-term viability.

ARPA 93-106 TITLE: Methods to Extract Annotations from Engineering Drawings and/or Maps

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Make legacy information now in engineering drawings accessible for maintenance and reuse.

DESCRIPTION: Engineering design information has been traditionally captured in engineering drawings. These drawings are usually large paper sheets, 24x36 inches or larger. These sheets contain both geometric data and text associated with portions of the geometry. To make such legacy information accessible for maintenance and use with newer CAD drawings and analysis tools, paper drawings must be converted to machine-readable representations. Most current research focuses on the geometry in existing paper drawings. An associated task is to extract nongeometric data on the drawings and associate it with the geometric data; examples of such data are: text, identifiers of components, industry standard symbols, measurements, tolerances, finishing instructions, connections, section references to other drawings, and title blocks. References on maps include depth, elevation contours, terrain descriptions, identifiers of natural and man-made features, man-made object descriptions, and other U.S. Coast and Geological Survey symbols. Text may be in printed, typed, lettered, hand-printed or written form. In addition, there is typically a specification block in one corner that includes spaces for approval signatures and corresponding dates. All this information should be extracted for labelling purposes. This research will provide methods to extract non-geometric data, create suitable files for further analysis, and support associating the entries with the geometric objects being represented digitally in those drawings. A convention should be established for illegible character sequences and unrecognized symbols. The goal is a complete, robust digital representation that captures all the syntax and semantics present in the original paper drawing. These digital representations should conform, as much as possible, to industry standards (such as those specified by IGES, PDES) for exchanging digital engineering data.

Phase I: Demonstrate base capabilities and create a plan for developing a product based on those capabilities.

Phase II: Develop and test modules in a realistic setting where both geometric and nongeometric data can be processed.

ARPA 93-107 TITLE: Methods, Support, and Languages to Control, Access, and Integrate Results of Simulation Programs from Remote Systems

CATEGORY: 6.1 Basic Research

OBJECTIVE: Bring the capabilities of modern simulation technologies into large and distributed, but at the same time maintainable and flexible, system architectures.

DESCRIPTION: Simulation is an important component of modern planning and decision-making processes. Today, most simulations are stand alone, that is, they are executed under direction of a user, who provides input information and inspects the results. Advanced simulation systems have been built that combine multiple simulations, allow activation through controlling programs, and distribute results for display at remote sites, in appropriate formats. Protocols are being developed to aid in the interpolation of simulations within certain domains. However, to improve the process of integrating simulations with each other and with other decision-aiding processes, new methods of system composition, support, and adaptation are needed. These new methods should: lead to reductions in cost and time for composition of systems involving simulations; increased flexibility and adaptability to changing needs, base capabilities, and system configurations; reduce the cost of system establishment and maintenance; and promote reuse of simulation components. Changes in needs may involve the precision, the time span, the due time, or the scope of a simulation. Changes in base capabilities can include improved access to data, increased computational power, as well as improvements in the models used in the simulations, perhaps adding parameters where no flexibility existed before. Systems configuration changes will include the number and accessibility of computational nodes, and perhaps connectivity to current measurements that allow improved simulation results. It is anticipated that languages and language-based tools will be needed to drive and support the creation and management of component-based simulations, so that changes, as listed above, can be rapidly and reliably expressed in high-level terms. Recompilation, rather than reprogramming, should be adequate to deal with most changes in the simulation environment, including replacement of simulator modules. The component simulations will execute in a widely distributed computing network environment and the natural parallelism of real-world events must be reflected in the language structure. It must be possible to express realistic constraints among the components, including real-time constraints, mismatch of real and simulation times, and failures of communication. The languages should be sufficiently formal to allow validation and verification of correct operation in real-time environments. They are likely to drive the evolving protocols used to control simulations, and affect their development; however, we expect that the actual simulations will continue to be developed in programming languages appropriate to their domain and heritage. Systems for composing simulations may require new programming environments. Proposals can be domain-specific, i.e., focus on a specific set of simulation applications and incorporate assumptions about the domain, or be more general. A more general approach is likely to require explicit declarations defining the domain, the system architecture, and the like. Domains can range from financial and budget planning, such as planning commonly done using spreadsheets, via simulations that evaluate the manufacturability, reliability, and even the marketability of products, to wide-ranging simulations that drive war-game exercises.

Phase I: Define the scope, the approach to method or language design and validation, a demonstration scenario, and the milestones of progress that can be applied to measure progress in this field. Planning of linkages to realistic experiments in Phases II or III of a possible award will be important.

Phase II: Due to the innovative nature of this topic we do not expect to award any Phase II contracts prior to the completion and evaluation of Phase I contracts.

ARPA 93-108 TITLE: Means to Facilitate Access to Public or Semi-Public Databases from Remote Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Provide access to data and information compiled and maintained in public or semi-public databases, permitting its direct use by remote application systems.

DESCRIPTION: A large portion of the information relied on by planning, logistics, manufacturing, and other decision-

makers derives from public and semi-public databases. We define semi-public as corporate or institutional databases that contain information that is available for use by select customers. Such databases include electronic reference libraries; airline, airfreight, rail, trucking and shipping schedules; weather, road and traffic information and predictions; supply, location, and other resource data; and rules and laws governing processing and shipping. Unfortunately, most of this information is either inaccessible or only accessible in formats that cannot readily be incorporated into automatic data-processing. This lack of database information leads to requirements for manual transcription and, in practice, to inefficient use of available facilities and resources. It is hoped that access to such information will become more conveniently accessible via the communication networks now being established. Data requests and responses should satisfy extant and emerging standards as far as practicable. Access to descriptive meta-data must be available as well, so receivers do not need to program extensive knowledge about the content, formats, scope, and significance of information. Arrangements must be made to inform users of changes in the meta-data, to enable rapid and economical maintenance of using programs. Consideration should be given to means of recording and monitoring accesses, with an eye to possible billing or other means of service reimbursement. Proposals should not only be technically correct, but should show that there is potential for a viable and long-lived business.

Phase I: Provide a coherent plan, including financial viability, of providing access to one or more valuable databases, and establish credible linkages with the owners of such data.

Phase II: Initiate an actual service to one or more such databases in its time frame, provide means for measuring its utilization, and quantify the costs and benefits of the service.

ARPA 93-109 TITLE: Advanced Multimedia Imaging Helmets

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop advanced multimedia imaging helmets for ship and ship systems design, construction, operation, and maintenance tasks.

DESCRIPTION: There is a need to develop advanced multimedia imaging helmets to provide a rich and robust interface between mobile operators and distributed, intelligent, highly automated computer-based systems. Concepts for one or more variants of a family of such helmets are required. As an example, the range of possible applications for ship and ship systems "operation-related" tasks includes, but is not limited to, development of helmets for mobile shipboard operators (command, fire control, damage control, machinery control, etc.) who must sense, process and display data locally while maintaining connectivity with other remote stations and operators and their distributed sensing, processing and display functionality. As a part of this effort, innovative concepts are sought for sensing, fusing and displaying multispectral imaging data with computer generated 3D CAD, text, and auditory representations in a helmet-based system, while at the same time permitting the operator normal visual and auditory sensing.

Phase I: Provide a conceptual design for one or more variants of a family of advanced imaging helmets. Demonstrate the extendibility of proposed concepts to related applications and provide a performance, cost and development risk trade-off analysis with appropriate metrics.

Phase II: Design and demonstrate a full-scale prototype of one or more variants of the proposed family of imaging helmets. Conduct performance and cost sensitivity analysis to demonstrate concept viability.

ARPA 93-110 TITLE: Intelligent Robotic Cranes and Fixtures for Manufacturing of Ship and Ship Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and demonstrate an intelligent and advanced, adaptable robotic cranes and test, fabrication, and assembly fixtures for manufacturing of ships and ship systems.

DESCRIPTION: There is a need to develop concepts for advanced, adaptable robotic cranes and test, fabrication, and assembly fixtures to support the automation of component manufacturing and construction-related processes for ships and ship systems.

Phase I: Provide a conceptual design for an intelligent, adaptable robotic crane or fixture and demonstrate the feasibility and potential of the proposed concept. Quantify performance characteristics and establish the expected constraints and limitations of the proposed concept through a combination of simulations, analysis, computations, and physical

experiments. Provide performance, cost and development risk trade-off analysis of selected design alternatives with appropriate metrics.

Phase II: Design and demonstrate a full-scale simulation and a subscale implementation of the proposed robotic crane or fixture. Conduct performance and cost sensitivity analysis to demonstrate the viability of the proposed design.

ARPA 93-111 TITLE: Advanced Marine Internal Combustion Engines

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop, for military application, advanced internal combustion engines with high power-to-weight ratios and low emissions and specific fuel consumption.

DESCRIPTION: Present marine engines fall into four major categories: high speed, medium speed, and low speed diesels, and open brayton cycle gas turbines. There is a need to develop and demonstrate advanced engine concepts, such as advanced diesel or closed brayton cycle engines, with power densities of less than two lbs/HP, that have favorable specific fuel consumption and emissions over a wide range of speeds and mission scenarios.

Phase I: Provide a conceptual design for an advanced internal combustion engine. Demonstrate the viability of the concept through a combination of simulations, computations, analysis, and subscale demonstrations. Provide a performance, cost and development risk trade-off analysis with appropriate metrics.

Phase II: Design and demonstrate the viability of the design through a combination of subscale and high-risk component demos, simulations, and analysis. Conduct performance and cost-sensitivity analysis of the proposed design.

ARPA 93-112 TITLE: Intelligent Planning and Control Systems for Rapid Response to and Mitigation of Maritime Oil Spills

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop concepts for oil spill response, including containment, mitigation, remediation, cleanup, disposal, monitoring and control using advanced air and surface deployed robotic marine vehicles. Incorporate advanced technologies from industry and ARPA.

DESCRIPTION: There is a need to develop concepts for the planning, deployment and control of advanced, intelligent systems for the rapid response to and mitigation of maritime oil spills. System concepts consisting of both air and surface deployed assets and incorporating technologies such as advanced robotic vehicles, artificial intelligence, advanced sensors, advanced materials, etc., are required to insure rapid and efficient planning and response to oil spill situations involving a wide range of both environmental and casualty-dependant constraints. Proposals should focus on high-payoff specific technology elements, as well as the performance and cost of overall system concepts.

Phase I: Provide a conceptual design for a planning, deployment and control system for the containment, mitigation, remediation, cleanup, disposal, and post-spill monitoring of maritime oil spills. Demonstrate concept feasibility through a combination of simulation and analysis. A trade-off analysis with appropriate metrics is required.

Phase II: Design and develop a full-scale simulation prototype for the integrated system and appropriate subscale software and hardware prototypes of selected high-payoff and innovative technologies and components. Conduct performance and cost-sensitivity analysis to demonstrate the viability of the concept design.

ARPA 93-113 TITLE: Advanced Embedded Sensors and Intelligent Control Systems for Internal Combustion Engine Performance Monitoring and Control

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop advanced embedded sensor and intelligent control systems for the performance monitoring and control of internal combustion engines.

DESCRIPTION: There is a need to develop advanced embedded sensor and control system technologies to sense, fuse and

process the diverse parameters associated with the performance monitoring and control of current and advanced internal combustion engines. Innovative intelligent sensor and sensor-processing technologies, ranging from microdynamic to fiber-optical, as well as other specialized discrete and array technologies are required. Artificial intelligence based software components to fuse, assess, reason, plan, and otherwise control the performance and emission-related parameters of such engines are required.

Phase I: Design and demonstrate a full-scale prototype of the proposed design. Conduct performance and cost-sensitivity analysis to demonstrate the viability of the concept.

Phase II: Provide a conceptual design for selected engine sensor(s) and/or for an intelligent performance monitoring and control system. Demonstrate the viability of the proposed concept through a combination of computations, simulations, analysis and subscale demonstrations. Provide a performance, cost and development risk trade-off analysis with appropriate metrics.

ARPA 93-114 TITLE: Dolphin/Bat Signal Processor and Classifier

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a sonic receiver, signal conditioner, signal-processing algorithm, and a neural-net realization of either the dolphin or bat sonar signal-processing system.

DESCRIPTION: Both the bat and the dolphin use high-frequency sonar to locate prey. Although these systems are radically different, both require the reception and processing of short-duration signals. The goal of this program is to develop a supervised neural network and signal processor that can be adapted to mimic either the dolphin or bat sonar. The project will also require development of a receiver, signal conditioner, and processing algorithms for either the dolphin or bat sonar. Emphasis should be placed on both the echo location capabilities of the sonar and the classification capabilities. If the neural-net technology is capable of satisfying both systems, then the work should incorporate a flexible architecture such that both can be treated in a sequential manner. The results of this effort will be used to study the echoes produced by both real animals and artificial means.

Phase I: Develop signal-processing schemes that are based on current research efforts at universities and naval laboratories for both the dolphin and bat sonar. Upon selection of either the bat or dolphin sonar, a receiver, signal conditioner, processing algorithm, and neural system will be designed and its applicability to the other animal assessed. The output from Phase I will include the candidate system design, a comparison of the bat and dolphin processing systems, and the specifications for procurement of prototype components.

Phase II: Procurement, assembly and laboratory testing of the neural-net processing. The laboratory testing should concentrate on the training of the net on artificial signals. After successfully completing the laboratory testing phase, the device should be field tested with both artificial and real signals. It is expected that during this phase the contractor will participate in the conduct of experiments using this device. The final report should discuss the applicability of this device to the dolphin/bat sonar not studied and make relevant recommendations regarding future applications.

ARPA 93-115 TITLE: Dolphin Sonar Transducer and Array

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop and build a transducer and focusing array that duplicates that of the dolphin.

DESCRIPTION: The dolphin has a unique sonar capability by which it produces high-frequency clicks. The Dolphin's forward-looking sonar beam is most likely produced with its larynx, then conditioned in the nasal passage wave guide and focused by the melon. The dolphin is able to vary both the frequency content and the repetition rate of the clicks. The goal of this project is to model the dolphin sonar and to design, construct, and build a transducer capable of mimicking the dolphin's behavior and ultimately to use this device to simulate the dolphin's ability to recognize objects.

Phase I: Phase I will consist of the modeling of the sonar and the performance of both laboratory and analytical studies to demonstrate the adequacy of the model. A prototype transducer and focusing array will be designed.

Phase II: The transducer/array will be fabricated, built and laboratory tested. Finally, the device will, in conjunction with designated Naval Laboratory personnel, be field tested and compared with the actual signals emitted by a dolphin and will be used in conjunction with recognition studies.

ARPA 93-116 TITLE: Sensors and Technologies for Fiber-Optic Sensing Systems

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop sensors and sensor technologies to be applied to fiber-optic sensing systems which will involve large numbers of miniature sensors on fiber-optic cables. The principle military application is underwater sensing.

DESCRIPTION: Arrays of underwater sensors are useful to the Navy. Rapid deployment of the sensors from an unmanned undersea vehicle or an airplane requires that the sensors and their cables be small, light, and easily unwound from a reel. For the cable to be small, it must use fiber-optic telemetry with the large number of sensors multiplexed on a small number of fibers. The sensors must be small enough not to interfere with the deployment mechanism. This project will develop the multiplexed sensors.

Phase I: Complete a preliminary design for the sensors and their multiplexing. Analyze critical issues of the design and demonstrate experimentally as necessary. Show that the sensors and cable will be small and lightweight when combined. Show how the sensors can be transitioned to production and how effective the sensors will be for military applications.

Phase II: Build and demonstrate arrays of multiplexed sensors. Show the performance that can be expected under a range of conditions. Develop an estimated cost of the sensors in production quantities. Develop a plan for transition of the sensors to production for civilian and/or military applications. If production will be for civilian applications, show how the same technology can be used to support military applications.

ARPA 93-117 TITLE: High-Density and Safe Storage for Unmanned Undersea Vehicles and Electric Land Vehicles

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop high-density and safe hydrogen storage systems to be used on unmanned undersea vehicles or other submersibles, or on electric land vehicles. Refueling should be accomplished either by refilling a tank with fluid or by replacement of a canister.

DESCRIPTION: Unmanned undersea vehicles, other submersibles, and electric vehicles can be powered efficiently and quietly by Proton Exchange Membrane (PEM) fuel cells, which require hydrogen as a fuel. For use of PEM fuel cells to be successful, refueling must be rapid and safe and large amounts of hydrogen must be stored on-board. On submersibles or electric vehicles, the PEM system will be advantageous only if the energy density of the system exceeds that of secondary batteries. In the case of submersibles, the specific goal is to reach and, preferably, to substantially exceed the energy density of liquid hydrogen. Both electric vehicles and submersibles can be refueled by refilling a tank with fluid (liquid or gas). Such systems could support rapid refueling, however steps must be taken to assure that the fuel is safe to handle. Alternatively, in the case of submersibles the hull may be opened in order to allow refueling by insertion of a canister containing the fuel or containing a chemical from which hydrogen can be generated.

Phase I: Complete a preliminary design of the hydrogen storage system and, as necessary, demonstrate critical issues experimentally. Show how the hydrogen storage system can be transitioned to production and how effective the hydrogen storage system will be for military applications.

Phase II: Build and demonstrate the hydrogen storage system. Develop an estimate of the cost of the storage system for submersibles and electric land vehicles. Develop plans to transition the system to production for civilian and/or military applications. If production will be for civilian applications, show how the same technology can be used to support military applications.

ARPA 93-118 TITLE: Compact and Efficient Reformer to Supply Hydrogen for Proton Exchange Membrane (PEM) Fuel Cell Stacks

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop a compact and efficient reformer to supply hydrogen for PEM fuel cell stacks. The reformer should be suitable for use in transportable equipment or vehicles.

DESCRIPTION: PEM fuel cells can convert hydrogen efficiently and cleanly into electricity. Hydrogen can be supplied by reforming hydrocarbon fuels such as methanol. A compact, efficient, reformer is required for transportable equipment and vehicles. The reformer must be able to follow the load, operate with minimal environmental impact, and generate a hydrogen stream compatible with PEM fuel cells. In particular, carbon monoxide levels must be low.

Phase I: Complete a preliminary design of the reformer and demonstrate critical issues experimentally as necessary. Show how the reformer can be transitioned to production. Also, show how effective the reformer will be for military use in transportable equipment or vehicles.

Phase II: Build and demonstrate the reformer. Show compatibility with a PEM fuel cell stack. Develop a cost estimate for the reformer produced in production quantities. Develop plans to transition the reformer to production. If production will be for civilian applications, show how the same technology can be used to support transportable equipment or vehicles for the military.

ARPA 93-119 TITLE: Components for Low-Cost, High-Performance and Robust Proton Exchange Membrane (PEM) Fuel Cells

CATEGORY: 6.2 Exploratory Development

OBJECTIVE: Develop new components required for low-cost, high-performance and robust PEM fuel cell stacks for undersea vehicles and electric land vehicles.

DESCRIPTION: PEM fuel cell stacks offer advantages for a number of applications. In order to realize these benefits it is necessary to improve on available stack technology. The goal of this project is to make and implement the required improvements. The list of desired improvements/characteristics includes: long life, low leakage, easy manufacture and assembly, low cost, ability to handle impure reactants, simplification of support hardware requirements, higher efficiency and power density, and reduced susceptibility to membrane dry-out. Areas/issues possibly relevant to achieving the project goal include electrolyte membranes, catalysts, fabrication methods, seals, reactant gas conditioning, low-cost subassemblies, and simplified stack construction.

Phase I: Complete a preliminary design of the new components and demonstrate, as necessary, critical issues involving their performance or manufacture. Show how the components can be transitioned to production. Show how effective the components will be for improving the cost, performance, or robustness of PEM fuel cell stacks for undersea vehicles or electric land vehicles.

Phase II: Build and demonstrate the new components for PEM fuel cell stacks. Develop a cost estimate for production quantities of the components. Develop a plan to transition the components to production. If production will be for civilian applications, show how the same components or technology can be used to support military applications.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Special Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; low signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extreme temperature environments; water depth and atmosphere pressure proof; certified transportable by aircraft, ship and submarine, and deployable by paradrop; LPI/LPD jam resistant C3; electronic warfare capable of disruption and deception; near real-time surveillance and intelligence; highly lethal and destructive; and compatible with conventional force systems. USSOCOM is therefore seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent an introduction to a portion of the problems encountered by the SOF in fulfiiing its mission.

USSOCOM invites the small business community to send its proposals directly to the following address:

United States Special Operations Command
Attn: SOKS/SBIR Program, Topic No. SOCOM93-_____
2408 Florida Keys Ave
MacDill Air Force Base, Florida 33621-5316

The proposals will be processed, then distributed to the appropriate technical office for evaluation. Inquiries of a general nature or questions concerning the administration of the SBIR program and proposal preparation should be addressed to:

United States Special Operations Command
Attn: Ms. Paulette Widmann
2408 Florida Keys Ave
MacDill Air Force Base, Florida 33621-5316
Tel: (813) 840-5443

The USSOCOM has identified three technical topics for its first SBIR Solicitation participation, to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. No direct communication with the topic author is possible.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior, or it may fund no proposals in a topic area.

SUBJECT/WORD INDEX TO THE SOCOM SBIR SOLICITATION

Index of U.S. Special Operations Command FY93 Topics

SOCOM93-001 TITLE: Aluminum Air Battery for Communications Equipment

CATEGORY: Advanced Development; Electrochemical Energy Conversion

OBJECTIVE: To design and demonstrate a reusable, mechanically rechargeable battery for potential use by SOF personnel in remote ground activities.

DESCRIPTION: Presently, batteries used for communications gear, etc., use conventional battery types (i.e., lithium sulfur-dioxide, nickel-cadmium) which do not store enough energy to complete the mission without replacement. This requires SOF personnel to carry extra batteries which significantly contributes to the weight and volume of their backpack load.

The offeror should design and demonstrate a battery and recharge kit using Aluminum/Air chemistry. The battery shall be mechanically rechargeable (by electrode and/or electrolyte replacement) in remote field conditions. The battery and recharge kit shall have a significantly greater energy storage density (both by weight and volume) than Nickel-Cadmium and Lithium Sulfur-Dioxide batteries. The battery should be of the voltage and peak power delivery capability as the military type BA-5590 and BB-590 batteries. The battery shall be safer; and easier to transport, handle and dispose of than Lithium Sulfur-Dioxide batteries.

Phase I: Develop and document battery design.

Phase II: Refine design, build development models and test in laboratory and field conditions.

Phase III: Produce batteries for use in military man-pack radios used by Army and Navy SOF forces as well as Army and Marine Conventional forces. Commercial, non-military applications exist in electric vehicles.

SOCOM93-002 TITLE: Very Shallow Water Mine Countermeasures

CATEGORY: Advanced Development, Bottom Mapping and Profiling

OBJECTIVE: To design and demonstrate a family of equipment to be used by Navy SEALs to find and neutralize underwater mines in very shallow water.

DESCRIPTION: Naval Special Warfare is developing and testing sensors, equipment and tactics to enhance the ability to locate and neutralize anti-invasion mines in the very shallow water maritime environment, over large areas in minimal time. Requirements exist for the following:

a. Enhanced real-time sonar signal processing techniques in side-scan sonars to incorporate modifications to include a true "zoom"; to select frequency, repetition rate, and beam width to match screen resolution to acoustic resolution (100% coverage, resolving a 1 sq ft object at 100yd) at a speed of 6-10 knots; and to incorporate positional data from GPS (or other) to an operator-designated cursor position for storage of object position. Testing conducted during 1992 demonstrated the ability of side scan sonars to support a wide area search to detect mine shapes in water depths as shallow as 6 feet and highlighted the shortfalls in signal processing and display associated with sensors optimized for the location of large objects in deep water.

b. A multi-beam side scan sonar that can be rigidly attached to the keel of a small boat to perform wide area searches for mine like objects at higher speeds than single beam side scan sonars are capable of. The sonar frequency, pulse width and repetition rate, beam width, and screen pixel display resolution must be chosen to optimize the performance of the system to locate mine size targets at a nominal range of 100 yd in water depths from 6-21 ft. The system must be fully operable at speeds between 3-10 knots in sea state III, from a 24 ft rigid inflatable boat.

c. A high-resolution handheld sensor to detect and image bottom targets to a combat swimmer at safe standoff ranges. Specifically an acoustic lens array and display system is required to provide resolution of less than 3 in. at a range of 20 yds, with a field of view of approximately 45 deg horizontally by 10 deg vertically.

d. A small device that would detonate the mine's explosive material within the mine would decrease the equipment the combat swimmer needs to carry. The device would shoot a projectile/detonator that penetrates the mine case and detonates the explosive within the mine after the swimmer had cleared the area. The neutralization system should weigh less than 5 pounds in air and should be effective when placed as far as 16 inches away from the mine case.

Phase I: Analyze requirements and develop prototype design for one or more of the above devices.

Phase II: Build an advanced development model(s) of the equipment. Perform laboratory tests and field tests on the equipment to determine their effectiveness.

Phase III: Design and build production prototypes to be used by Navy divers performing mine clearance

missions. Units could also be used by military or commercial divers performing underwater salvage and recovery.

SOCOM93-003 TOPIC: Imagery/High-Speed Fleet Broadcast Receive Only Capabilities for MATT

CATEGORY: Engineering Development: Radio Frequency Communications/Data Acquisition and Conversion

OBJECTIVE: Design and develop upgrade kits for the Multi-Mission Advanced Tactical Terminal (MATT).

DESCRIPTION: Design, develop, and test hardware and software modules which can be added to the core MATT configuration to receive, demodulate, deinterleave, decode, decrypt, and process imagery and high-speed fleet broadcast data. The deliverables will be imagery and high-speed fleet broadcast hardware and software in SEM-E configuration plus a set of software configuration items. The design of the modules will be such that they do not in any way adversely effect the existing interfaces or system performance, and operate with the same interfaces. The modules will consist of kits that can be added to existing MATT units as a plug-in modification.

Phase I: Design a prototype kit.

Phase II: Fabricate, test and document prototype.

Phase III: Produce kits for MATT production units.

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[illegible]

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APPENDIX A

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

Reference A

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 93.2
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________________ ____________
Signature by receiving organization Date

Reference B

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires August 2, 1993, the DoD SBIR Program Solicitation No. 93.2 closing date.

REQUESTER ______________________________
Name

ORGANIZATION NAME ______________________________

ADDRESS ______________________________
Street

______________________________ PHONE ______________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1 ________	6 ________		11 ________	16 ________
2 ________	7 ________	*PLEASE TYPE OR PRINT IN THE*	12 ________	17 ________
3 ________	8 ________	*ORDER TOPICS APPEAR IN THE*	13 ________	18 ________
4 ________	9 ________	*SOLICITATION*	14 ________	19 ________
5 ________	10 ________		15 ________	20 ________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____no____.

____
Signature of Requester

========================FOLD HERE========================

STAMP

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Building 5, ATTN: SBIR
Cameron Station
Alexandria, VA 22304-6145

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Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (TN, NC, SC, MS, AL, LA, FL)
(404) 590-6196

DCMAO Atlanta
ATTN: Evelyn Taylor
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMAO Orlando
ATTN: Russell Nielson
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5153

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(512) 229-4650

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Victor Irizarry
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318

DCMAO Boston
ATTN: Gerald Hyde
495 Summer Street
Boston, MA 02210-2184
(617) 451-4109

DCMAO Bridgeport
ATTN: Otis Wade
555 Lordship Boulevard
Stratford, CT 06497-7124
(203) 385-4412

DCMAO Garden City
ATTN: John Richards
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5724

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7707/7705

DCMAO New York
ATTN: John Castellane
201 Varick Street, Room 1061
New York, NY 10014-4811
(212) 807-3050

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 423-5405/5207

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260

DCMAO San Francisco
ATTN: Robert Lane
1250 Bay Hill Drive
San Bruno, CA 94066-3070
(415) 876-9523/9524

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 200
San Diego, CA 92111-2241
(619) 495-7459/7467

DCMAO El Segundo
ATTN: Lawrence Bogus
222 N. Sepulveda Boulevard
El Segundo, CA 90245-4320
(310) 335-3511

DCMAO Seattle
ATTN: Alice Toms
Building 5D, US Naval Station
Seattle, WA 98115-5010
(206) 526-3451

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92712-2700
(714) 836-2913

DCMAO Van Nuys
ATTN: Diane Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6177

DCMD MID-ATLANTIC
ATTN: Thomas Corey
2800 S. 20th Street, PO Box 7478
Philadelphia, PA 19101-7478
(800) 843-7694 (Toll Free PA Only)
(800) 258-9503 (Toll Free-DC,DE,MD,NJ,VA,WV)
(215) 737-4006

DCMAO Baltimore
ATTN: Gregory Prouty
200 Towsontown Boulevard West
Towson, MD 21204-5299
(410) 339-4809

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
c/o Defense Electronics Supply Center
Building 1, 1507 Wilmington Pike
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburg
ATTN: Fred Fundy
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
45 South Front Street
Reading, PA 19602-1094
(215) 320-5012

DCMAO Springfield
ATTN: Charles Ferraro
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8204

DCMD NORTH CENTRAL (DCMDC-DU)
ATTN: James Kleckner
O'Hare International Airport
10601 West Higgins Road
PO Box 66926
Chicago, IL 60666-0926
(800) 637-3848 (Toll Free)
(312) 825-6020

DCMAO Ceder Rapids
ATTN: Norma Kirkley
1231 Park Place, NE
Ceder Rapids, IA 52402-1251
(319) 378-2009

DCMAO Chicago
ATTN: Norma Thorpe
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021/6866

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381

DCMAO Grand Rapids
ATTN: Kay Hamilton
Riverview Center Building
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO Milwaukee
ATTN: Fredric Wolden
Henry S. Ruess Federal Plaza
310 West Wisconsin Avenue
Milwaukee, WI 53203-2216
(414) 297-4328

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5367

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive
Bloominton, MN 55425-1911
(612) 335-2003

DCMAO Wichita
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Prescribed by ANSI Std 239-18
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C	- Contract	PR	- Project
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